User's Guide

ECG Interpretation Program

ECAPS12C

For Bedside Monitors

0614-006465

NIHON KOHDEN

If you have any comments or suggestions on this manual, please contact us at: www.nihonkohden.com

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Section 1 INTRODUCTION

ECAPS 12C is the ECG analysis program for the NihonKohden's instruments, such as electrocardiographs. A computer analysis program is merely a collection of ECG evaluation criteria created by physicians. It is not possible for a computer program to correctly judge every unique ECG, so sometimes it makes wrong interpretations where a physician could very easily read and interpret the waveforms. The final decision can only be made by the qualified physicians. Use this system only as a diagnostic aid, based on proper understanding of its features and limitations.

This manual describes the criteria of the analysis results of the ECAPS 12C output data.

For the detailed operation procedure of the system, refer to the operator's manual of the instrument.

********** **Note** **********

The contents of this manual are subject to change without prior notice for improvement of analysis precision.

****

ADVISORY

The ECAPS 12C analysis program is applicable to ages 3 and older.
Ages below 3 years are treated according to the criteria for the age of 3 years.

Final determination of overall interpretation judgement, diagnosis and treatment must be made by a qualified physician.

◆Patient Age and the Age Used for Analysis

- When classifying as adult or child:

Age	Age which is used for analysis
Child (3 - 15)	12
Adult (≧16)	35

- When classifying in age range:

Age	Age which is used for analysis
≦5	3
6 - 9	7
10 - 14	12
15 - 34	25
≧34	35

- When patient's actual age is entered:
  The patient's actual age is used for analysis.

Section 2 PRECAUTIONS (Discrepancies between physician's and ECAPS 12C's findings)

The causes for discrepancy between computer analysis and physician's findings and the countermeasures to be taken for these causes are given below.

Causes	Countermeasures
Difference in judgement criteria between physician and computer program, or lack of applicable findings by computer program.	Refer to Section 6 "CRITERIA OF FINDINGS" which list all the judgement criteria used by ECAPS 12C.
The ECG waveform is on the borderline of the judgement criteria.	Compare the measured data with the data in Section 6 "CRITERIA OF FINDINGS". This may be the limit of computer analysis. Patient data other than ECG should be taken into consideration.
Artifact (EMG, AC interference, baseline wandering, etc.) not recognized, leading to wrong interpretation.	Try to record ECG with as little artifact as possible.
Arrhythmia, etc. which are intrinsically difficult for the computer to analyze.	This is a limit for computer analysis. The advice of a physician should be obtained.

Although various means of eliminating errors and discrepancies between computer analysis and physician's findings are employed in the ECAPS 12C, not all ECG diagnostic cases are incorporated, therefore, consider the following points when using the computer's analysis results.

(1) ECAPS 12C is not programmed to compensate for the influence of medicine. Check the dosing record when reading the ECG. However, the influence of digitalis is noted on the recording paper according to the presence of atrial fibrillation.

(2) ECAPS 12C is not programmed to compensate for fluid balance such as abnormal electrolytes. When interpreting ECG, read the QTc interval, T waveform and U waveform, along with other relevant test results.

(3) ECAPS 12C does not further classify premature complex into trigeminy, short-run, etc.

(4) ECAPS 12C is not programmed to identify escaped beats and pararrhythmia. These may be interpreted as "undetermined rhythms".

(5) ECAPS 12C is not programmed to identify LGL syndrome . Judge this syndrome from "short PR interval".

(6) ECAPS 12C does not identify wandering pacemakers.

Section 3 OUTLINE OF ECG AUTOMATIC RECORDING

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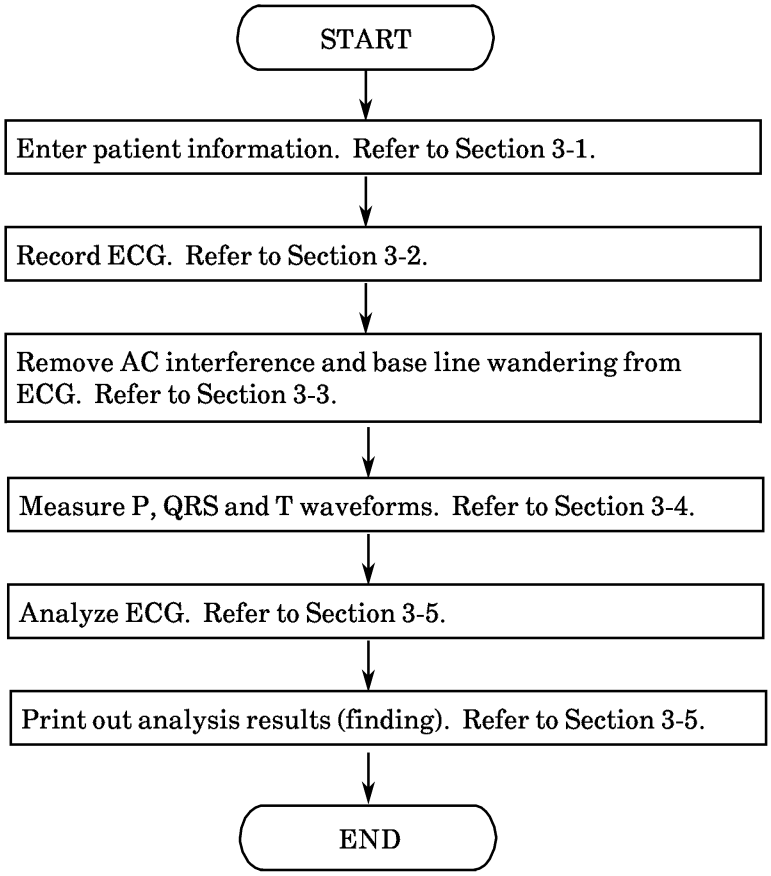
ECG Measurement Flowchart


START
Enter patient information. Refer to Section 3-1.
Record ECG. Refer to Section 3-2.
Remove AC interference and base line wandering from ECG. Refer to Section 3-3.
Measure P, QRS and T waveforms. Refer to Section 3-4.
Analyze ECG. Refer to Section 3-5.
Print out analysis results (finding). Refer to Section 3-5.
END

3-1 Entering Patient Data

Enter the following data before acquiring ECG data. With some instruments, some of these items cannot be entered. Refer to the operator's manual of the instrument for details of entering the patient data.

- Patient identification number (ID)
- Name
- Sex
- Birth Date
- Age
- Height
- Weight
- Blood pressure
- Medication
- Date *
- Hour *

  * Date and hour are automatically set.

NOTE

- **Among these items, only age and sex affect the analysis. Other items have no effect on the analysis.**
- **If no age is input, the factory default setting of 35 is used. If no sex is specified, the factory default setting of male is used.**
- **For accurate analysis results, input sex and age.**

3-2 Recording ECG Data

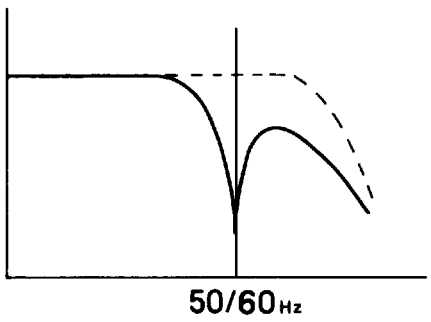
The ECGs of all 12 standard leads are acquired simultaneously for 10 seconds at an accuracy of 1.25 μV/bit and 500 samples/s.

Refer to the operator's manual of the instrument for details of recording ECG.

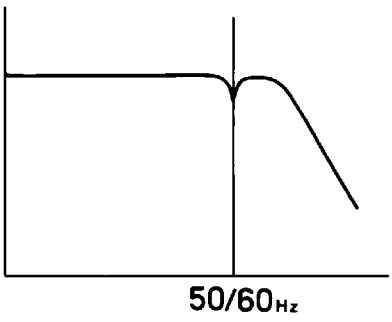
3-3 Improving Waveform Quality

During ECG data acquisition, the quality of the ECG waveforms is improved with digital filters and the adverse influence of baseline wandering due to electrode potential drifting and AC interference is minimized.

- AC interference
  A digital filter is used in the system to reduce the AC frequency components. A digital filter eliminates adverse influence on the ECG waveform more than a conventional analog filter .

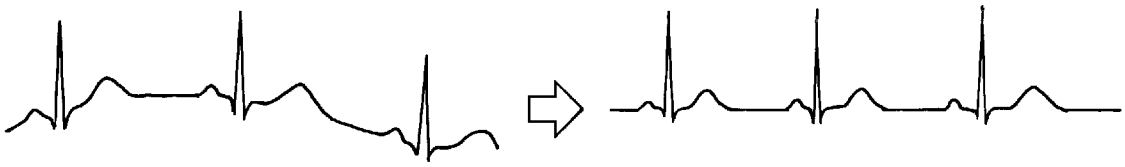


Conventional analog filter



Digital filter

- Baseline wandering
  Shortening the time constant distorts the ST segments which reduces diagnostic accuracy. A digital filter is used to remove the components which cause baseline wandering.



- High frequency noise
  High cut filters of different frequencies are incorporated in the instruments. The high cut filter cuts the high frequency components of ECG but reduces the effect of EMG. The high cut filter attenuates the QRS amplitude although the influence on judgement of LVH (left ventricular hypertrophy) is reduced as much as possible. However, the ECAPS 12C program always analyzes the ECG waveform acquired by 150 Hz filter. Therefore, some differences may occur between the recorded waveform and the analysis result.

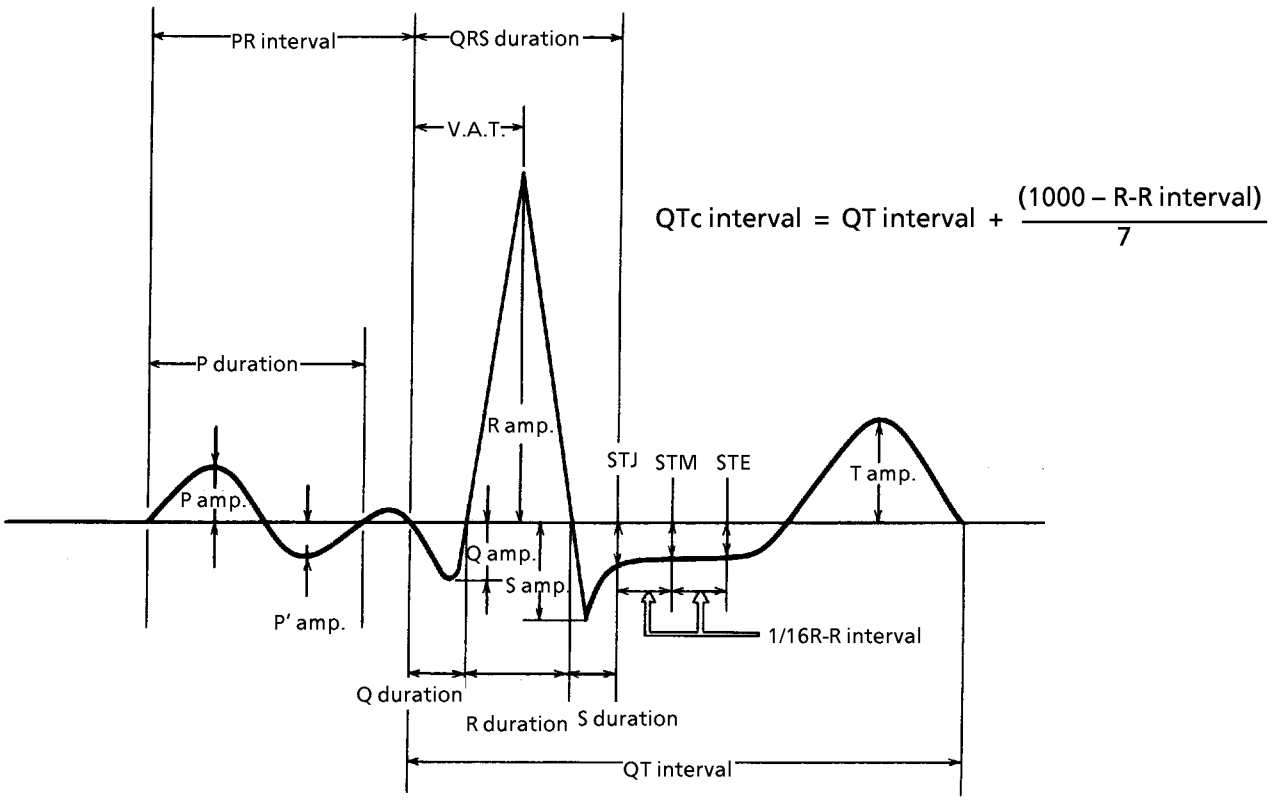
3-4 Measuring ECG Waveform

ECG waveforms are measured as shown below.

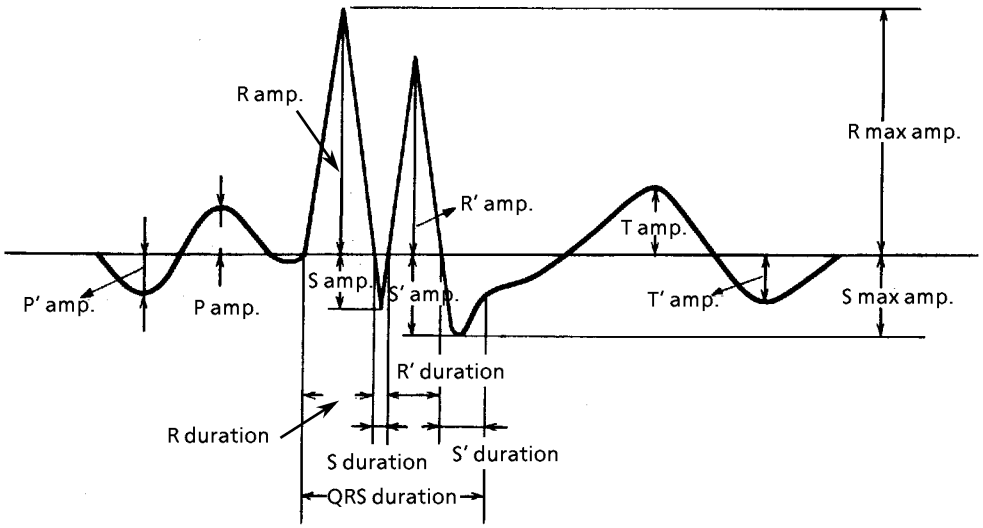
QRS wave detection	
↓	
QRS wave pattern classifying	QRSs are classified by patterns and only the typical waveforms are extracted and averaged for measurement.
↓	
P wave detection and waveform measurement	The P waves for each heartbeat are searched and classified by pattern.
↓	
Typical P wave detection	The most characteristic P wave pattern among the classified patterns is taken as the typical P wave.
↓	
Measuring P wave, QRS wave, T wave and ST segment	P wave, QRS wave, T wave and ST segment are measured. For the detailed measurement method, refer to the next page.
↓	
Rhythm analysis	Rhythm is analyzed based on QRS wave and P wave waveform measurement data.

Waveforms are measured as shown on the next page.
The reference point in measuring waveforms is the starting point of the QRS wave.

(a) Waveform measurement parameters

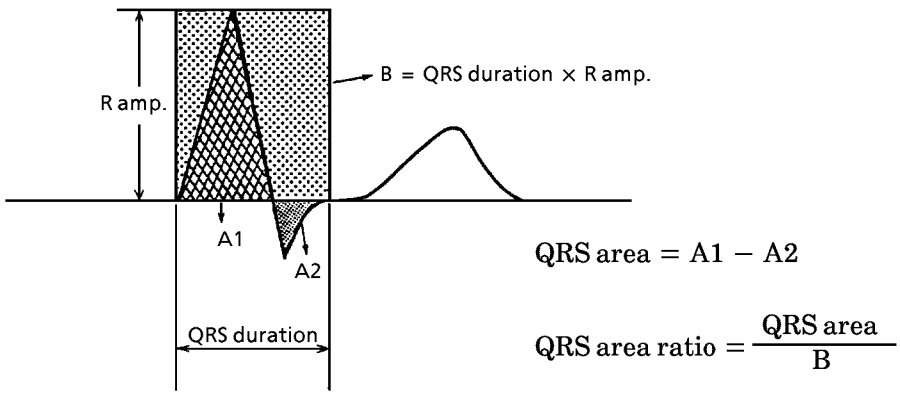


$$\text{QTc interval} = \text{QT interval} + \frac{(1000 - \text{R-R interval})}{7}$$

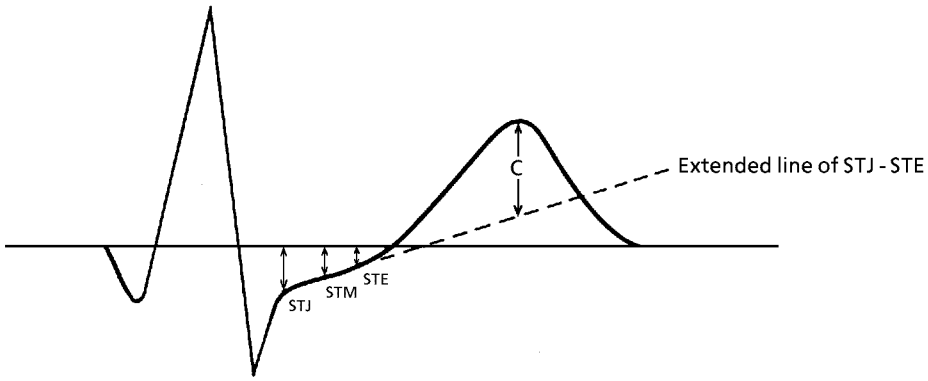


Total QRS amplitude = R max. amp. + S max. amp.
Net QRS amplitude = R max. amp. − S max. amp.

(b) QRS area



(c) Upward oriented T



T is upward oriented: $C > 0.05\ mV + (1.5 \times STJ)$

(d) Modified T amplitude (T amp. (mod))

To simplify the treatment of biphasic T wave, and to explain the T amplitude when ST and T differ from the QRS starting point, T amplitude is modified as below.

When T' is present:

T amp.(mod) = (T amp. or T'amp., whichever is smaller) − (STE or T end, whichever is larger)

When T' is not present:

T amp. (mod) = T amp. − (STE or T end, whichever is larger)

◆General Measurement Values to Be Printed

Printout	Meaning
Vent. rate --bpm	Heart rate
PR int. --ms	PR interval
QRS dur. --ms	QRS duration
QT int. --ms	QT interval
QTc int. --ms	QTc interval (See p. 3-6 (a))
P axis --°	P axis deviation
QRS axis --°	QRS axis deviation
T axis --°	T axis deviation

3-5 Classification and Printing ECG Data

The ECGs are classified into the findings.
(For the details of the classification method, refer to Section 6 "CRITERIA OF FINDINGS".)

The findings are printed out as "Analysis Result". Refer to the next section.

Section 4 RECORDED ANALYSIS RESULTS

The analysis results of the system are printed out in the format selected by the operator. The outline of the formats and the operation are described in the operator's manual of the instrument. The explanation of the common features of the printout with typical examples are given below. These are factory default settings.

Not all of the following items are printed with some instruments. For details, refer to the operator's manual of the instrument.

(1) Patient's data and recording conditions

① Date and Time
② Name
③ ID No.
④ Room
⑤ Sex
⑥ Birth date and Age (in some formats, birth date is omitted): years
⑦ Height: cm/inch
⑧ Weight: kg/lb
⑨ Systolic BP: mmHg/kpa
⑩ Diastolic BP: mmHg/kpa
⑪ Medication
⑫ Vent. rate (Heart Rate)
⑬ Paper speed
⑭ Sensitivity
⑮ Lead name

NOTE
①,⑫,⑬,⑭ and⑮ are automatically entered. Items② to ⑪ are printed as entered by the operator. Room No., Physician name and Technician name can be recorded according to the format.

(2) ECG waveform printout (In some formats, these are omitted.)

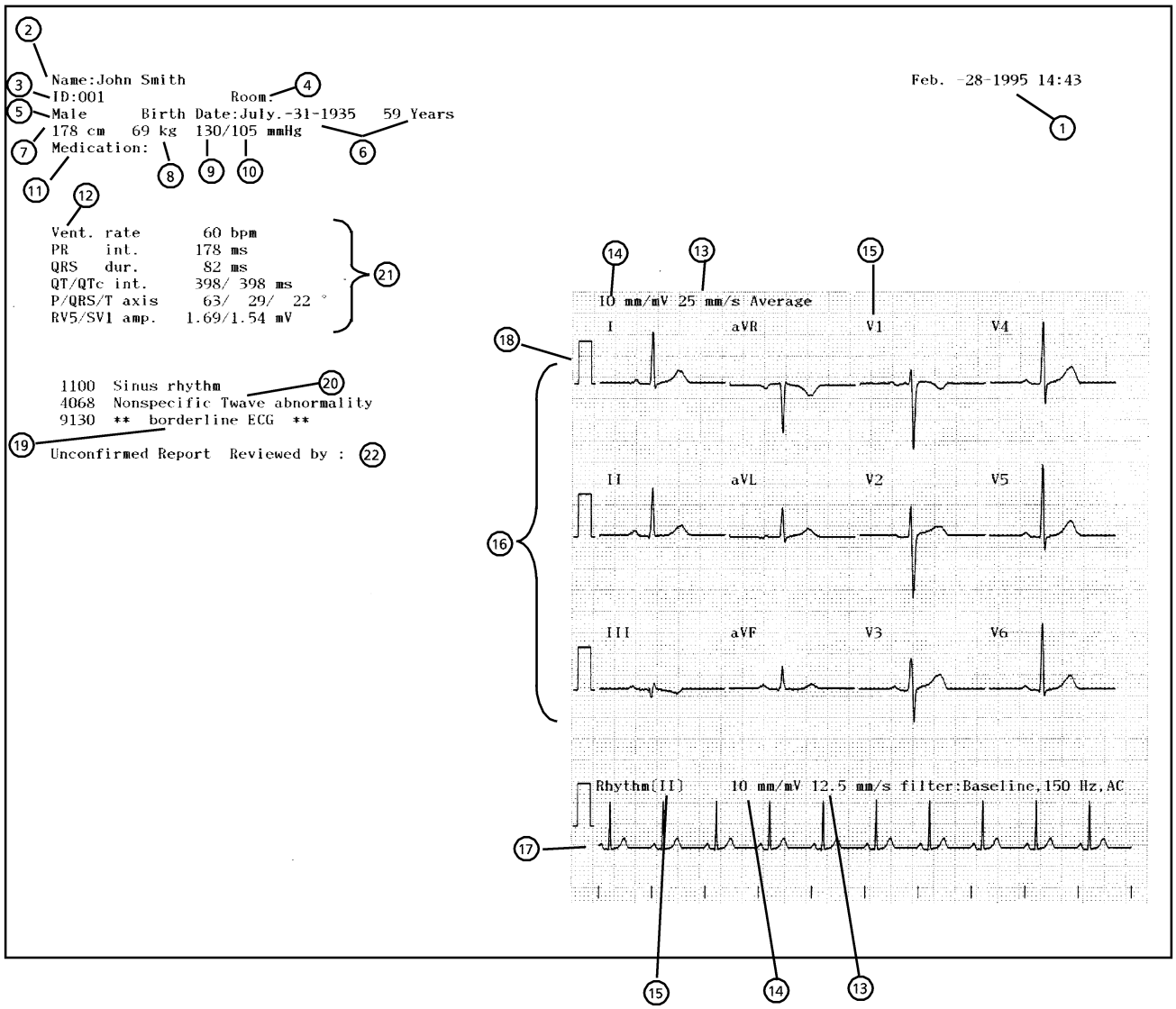
⑯ Dominant ECG waveform (averaged)
⑰ Rhythm lead
⑱ Calibration wave

(3) Analysis result

⑲ Overall judgement
⑳ ECG findings name [criteria]
㉑ Measurement values
㉒ Physician's signature (Reviewed)

NOTE

- The findings [criteria] are printed as a supplementary which is one of the judgement criteria. For details, refer to Section 5 "How to Read Analysis Results".
- In some findings, [criteria] are not printed.

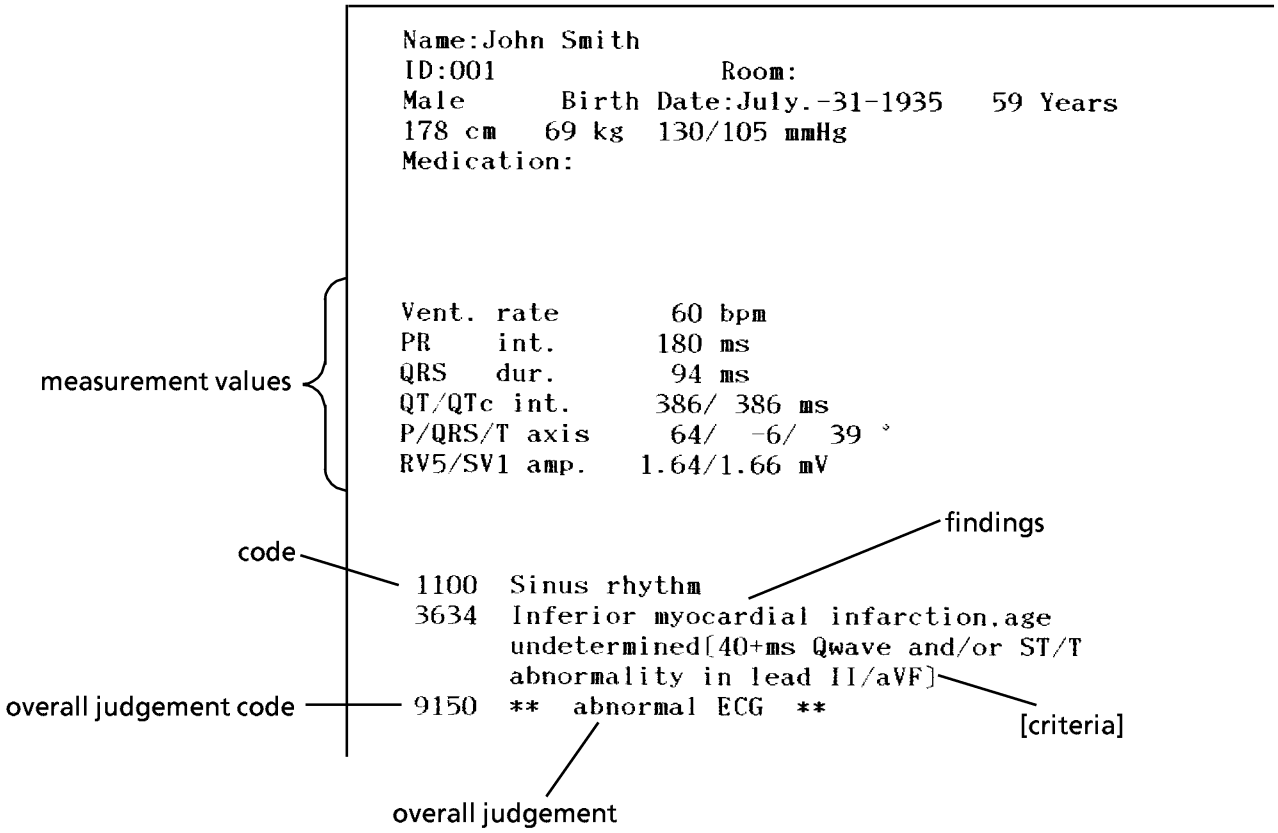

Name:John Smith
ID:001
Room:
Male
Birth Date:July.-31-1935
59 Years
178 cm
69 kg
130/105 mmHg
Medication:
Feb. -28-1995 14:43
Vent. rate 60 bpm
PR int. 178 ms
QRS dur. 82 ms
QT/QTc int. 398/ 398 ms
P/QRS/T axis 63/ 29/ 22 °
RV5/SV1 amp. 1.69/1.54 mV
1100 Sinus rhythm
4068 Nonspecific Twave abnormality
9130 ** borderline ECG **
Unconfirmed Report Reviewed by :
10 mm/mV 25 mm/s Average
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
Rhythm(II) 10 mm/mV 12.5 mm/s filter:Baseline,150 Hz,AC

Section 5 HOW TO READ ANALYSIS RESULTS

5-1 ECG Findings 5-2
5-2 Priority of ECG Findings 5-2
5-3 Criteria 5-3
5-4 Overall Judgement 5-3

The analysis result printout, as shown below, contains the following data.

1. ECG findings
2. Criteria
3. Overall judgement
4. Measurement values



5-1 ECG Findings

The ECAPS 12C classifies the ECGs into about 200 findings by comparing the features of the ECGs with the analysis criteria specified for each finding. The analysis criteria are all taken from the judgement criteria used by the physicians and arranged for computer processing. For details, refer to Section 6 "CRITERIA OF FINDINGS".

For the analysis process, refer to Section 3 "OUTLINE OF ECG AUTOMATIC RECORDING".

When the obtained ECG exactly conforms to the analysis criteria, the finding name is classified as "determined". However, there are findings which cannot be determined definitely and findings which are on the borderline between conformance and nonconformance, liable to be influenced by slight noises. Those findings which are close to "determined" but not definite are classified as "possible", and those findings which may or may not conform but cannot be completely ruled out are classified as "Cannot rule out". Some arrhythmia ECGs are difficult to classify into finding names; these are classified as "undetermined rhythm".

NOTE

When the ECG is classified as "undetermined rhythm" (1901, 1902, 1921, 1922, 1931, 1932), there is no further rhythm analysis.

5-2 Priority of ECG Findings

When the obtained ECG conforms to two or more findings criteria, only the most important finding name is printed. For example, if "ischemia" is found to apply, less important findings such as "nonspecific ST & T wave abnormality" or "ST elevation" are not printed.

Further details of analysis are given as NOTE under the respective findings in Section 6 "CRITERIA OF FINDINGS".

5-3 Criteria

The analysis criteria can be printed out following the findings on the recording paper, as shown on p. 5-1. They should serve as an aid in observing the ECG.

For reading convenience, the analysis findings and criteria are printed in simplified form. In the findings, " / " indicates OR, and " + " indicates AND.

For further details of the analysis criteria, refer to Section 6 "CRITERIA OF FINDINGS".

5-4 Overall Judgement

The findings are classified into one of five overall judgements. The list of all findings for each overall judgement is shown in Section 6 "CRITERIA OF FINDINGS".

	Overall Judgement	Code
1	abnormal ECG	9150
2	abnormal rhythm ECG	9140
3	borderline ECG	9130
4	normal ECG	9110
5	atypical ECG	9120

Where two or more findings are output, only the highest priority finding is printed. Although only the highest priority finding is selected for judgement, the findings requiring immediate treatment, such as "Myocardial infarction, possible acute" are printed as "abnormal ECG" instead of "borderline ECG". This is to raise an alarm in case of emergency although there is actually little possibility of danger. When an unusual ECG pattern is recognized as neither "normal ECG" nor "abnormal ECG", it is judged as "atypical ECG" For example, "Low QRS voltage", "undetermined axis", and "undetermined rhythm" are judged as "atypical ECG".

Section 6 CRITERIA OF FINDINGS

6-0	Indication of Analysis Criteria	6-0-1
6-1	Arrhythmias	6-1-C1
6-2	Conductive Defect	6-2-C1
6-3	Myocardial Infarction	6-3-C1
6-4	ST-T Abnormality	6-4-C1
6-5	Ventricular Hypertrophy	6-5-C1
6-6	Atrial Enlargement	6-6-C1
	Axis Deviation	6-6-C1
	Others	6-6-C1

Indication of Analysis Criteria

1. How to read analysis criteria
   The analysis criteria are marked with (1), (2) and ①, ②.
   (1) ··· indicates AND
   ① ··· indicates OR

【 Example 1 】

(1) condition A
(2) condition B
(3) ① condition C
② condition D

} Conditions A **and** B are satisfied, **and** either condition C or condition D are satisfied.

【 Example 2 】

(1) ① condition A
② ● condition B
● condition C

} Either condition A is satisfied, **or** both conditions B and C are satisfied.

2. Age reference tables
   The following tables show the values used for certain analysis parameters which vary according to age. The applicable items are marked with "*" in the criteria column.

NOTE

- **When no age is input in the patient information, the factory default setting of age 35 is used.**
- **When the age is less than 2, the computer's results may not be accurate.**

【 PR interval 】(%)

Age	PR ratio
≦5	76
≦9	83
≦11	85
≦14	88
≦18	91
>18	100

(Example)

PR interval = 170 ms
Age = 6 years old
PR criteria = PR int × PR ratio/100
= 170 × 83/100
= 141 ms

【 QRS duration 】(%)

Age	QRS duration
≦5	82
≦9	85
≦11	85
≦14	92
≦18	95
>18	100

【 Example 】
QRS duration : 0.12 s
Age = 10 years old
QRS criteria = QRS dur. × QRS dur(%)/100
= 0.12 × 85/100
= 0.102 s

【 S duration: Lateral lead (I, aVL, V4, V5, V6) 】(s)

Age	S duration	S duration
	0.040 (s)	0.060 (s)
≦5	0.031	0.047
≦9	0.034	0.051
≦11	0.037	0.056
≦14	0.039	0.059
≦18	0.039	0.059
>18	0.039	0.059

shows the parameters used in criteria for each finding.

【 R duration (V1, V2) 】(s)

Age	R duration	R duration
	0.020 (s)	0.030 (s)
≦5	0.016	0.024
≦9	0.017	0.026
≦11	0.019	0.028
≦14	0.020	0.030
≦18	0.020	0.030
>18	0.020	0.030

shows the parameters used in criteria for each finding.

【 R duration (I, aVL, V4, V5, V6) 】(s)

Age	R duration	R duration	R duration
	0.060 (s)	0.100 (s)	0.250 (s)
≦ 5	0.049	0.082	0.207
≦9	0.051	0.086	0.218
≦11	0.054	0.090	0.228
≦14	0.057	0.095	0.240
≦18	0.059	0.099	0.250
>18	0.059	0.099	0.250

shows the parameters used in criteria for each finding.

【 Electrical axis (left axis) 】(degree)

Age	LAXD1		LAXD2	
	Male	Female	Male	Female
≦ 5	15°	19°	5°	9°
≦ 9	9°	9°	−1°	−1°
≦ 11	4°	23°	−6°	13°
≦ 14	5°	20°	−5°	10°
≦ 18	−14°	13°	−24°	3°
> 18	−20°	−20°	−30°	−30°

【 Electrical axis (right axis) 】(degree)

Age	RAXD1		RAXD2	
	Male	Female	Male	Female
≦ 5	97°	101°	107°	111°
≦9	97°	97°	107°	107°
≦11	92°	100°	102°	110°
≦14	97°	97°	107°	107°
≦18	99°	100°	109°	110°
>18	90°	90°	100°	100°

【 R amplitude (V1) 】(mV)

Age	Male	Female
≦ 5	2.20	1.75
≦9	1.65	1.60
≦11	1.30	1.40
≦14	1.60	1.20
≦18	1.40	1.15
>18	1.00	1.00

【 Average R amplitude (V1) 】(mV)

Age	Male	Female
≦ 5	0.90	0.85
≦9	0.75	0.65
≦11	0.60	0.55
≦14	0.70	0.45
≦18	0.60	0.40
>18	0.40	0.30

【 R amplitude (V6) 】(mV)

Age	Male	Female
≦ 5	1.45	1.45
≦9	1.70	1.65
≦11	1.65	1.50
≦14	1.60	1.35
≦18	1.50	1.20
>18	1.20	1.00

【 S depth (V1) 】(mV)

Age	Male	Female
≦ 5	1.20	1.25
≦9	1.20	1.25
≦11	1.35	1.30
≦14	1.50	1.15
≦18	1.65	1.15
>18	1.20	0.95

【 S depth (V6) 】(mV)

Age	Male	Female
≦ 5	0.54	0.54
≦9	0.65	0.60
≦11	0.61	0.61
≦14	0.47	0.35
≦18	0.50	0.36
>18	0.40	0.30

【 R/S (V1) ratio 】

Age	Male	Female
≦ 5	2.7	2.0
≦9	1.8	1.8
≦11	2.3	1.3
≦14	2.2	1.6
≦18	1.3	1.7
>18	1.0	1.0

【 VAT (V1) 】(s)

Age	Male	Female
≦ 5	0.037	0.039
≦9	0.033	0.029
≦11	0.045	0.028
≦14	0.041	0.032
≦18	0.039	0.034
>18	0.050	0.050

【 Heart Rate 】(BPM) – For arrhythmia analysis –

Age	Bradycardia base	Tachycardia base
≦ 5	65	140
≦8	60	135
≦12	55	130
≦16	50	120
>16	50	100

BPM : Beats per minute

6-1 Arrhythmias

Rhythm analysis		6-1-C2
1002	Marked rhythm irregularity, possible non-conducted PAC, SA block, AV block, or sinus pause	6-1-10
1100	Sinus rhythm	6-1-1
1102	Sinus arrhythmia	6-1-11
1108	Marked sinus arrhythmia	6-1-11
1120	Sinus tachycardia	6-1-1
1130	Sinus bradycardia	6-1-1
1200	Atrial rhythm	6-1-2
1210	Atrial fibrillation	6-1-5
12101	Atrial fibrillation with rapid ventricular response	6-1-5
12102	Atrial fibrillation with slow ventricular response	6-1-5
12103	Atrial fibrillation with aberrant conduction, or ventricular premature complexes	6-1-16
12108	Atrial fibrillation with rapid ventricular response with aberrant conduction, or ventricular premature complexes	6-1-16
12109	Atrial fibrillation with slow ventricular response with aberrant conduction, or ventricular premature complexes	6-1-16
1220	Rapid atrial rhythm	6-1-2
1250	Atrial flutter	6-1-6
12503	Atrial flutter with aberrant conduction, or ventricular premature complexes	6-1-17
12505	Cannot rule out atrial flutter	6-1-6
1300	Junctional rhythm	6-1-3
1320	Rapid junctional rhythm	6-1-3
1400	Undetermined rhythm (Possible supraventricular rhythm)	6-1-4
1420	Undetermined rhythm (Possible supraventricular tachycardia)	6-1-4
1430	Undetermined rhythm (Possible supraventricular bradycardia)	6-1-4
1470	with occasional supraventricular premature complexes	6-1-12
1474	with frequent supraventricular premature complexes	6-1-12
1475	with frequent supraventricular premature complexes in a pattern of bigeminy	6-1-12
1570	with occasional ventricular premature complexes	6-1-13
15708	with occasional ventricular premature complexes (Unreliable analysis due to noise)	6-1-13
1574	with frequent ventricular premature complexes	6-1-13
15748	with frequent ventricular premature complexes (Unreliable analysis due to noise)	6-1-13
1575	with frequent ventricular premature complexes in a pattern of bigeminy	6-1-13
15758	with frequent ventricular premature complexes in a pattern of bigeminy (Unreliable analysis due to noise)	6-1-13
1577	with couplet ventricular premature complexes	6-1-13
15778	with couplet ventricular premature complexes (Unreliable analysis due to noise)	6-1-13
16006	Electronic atrial pacemaker	6-1-7

16007	Electronic ventricular pacemaker	6-1-7
16008	Electronic atrial pacemaker (Unreliable analysis due to noise)	6-1-7
16009	Electronic ventricular pacemaker (Unreliable analysis due to noise)	6-1-7
1901	Undetermined regular rhythm	6-1-8
1902	Undetermined rhythm	6-1-8
1921	Undetermined regular rhythm (tachycardia)	6-1-8
1922	Undetermined rhythm (tachycardia)	6-1-8
1931	Undetermined regular rhythm (bradycardia)	6-1-8
1932	Undetermined rhythm (bradycardia)	6-1-8
1938	Extreme bradycardia	6-1-9
1970	with occasional ectopic premature complexes	6-1-15
19708	with occasional ectopic premature complexes (Unreliable analysis due to noise)	6-1-15
1974	with frequent ectopic premature complexes	6-1-15
19748	with frequent ectopic premature complexes (Unreliable analysis due to noise)	6-1-15
1975	with frequent ectopic premature complexes in a pattern of bigeminy	6-1-15

Rhythm analysis

Arrhythmia analysis is divided into three major categories; "basic rhythm analysis", "basic rhythm fluctuation analysis", and "premature complex analysis". In the basic rhythm analysis, the presence of P wave and P wave axis are important factors. The connection between P waves and QRS waves is an important factor in classifying the waveform into basic rhythm, basic rhythm fluctuation and premature complex.

1. Basic rhythm analysis

(1) With P wave

●Sinus

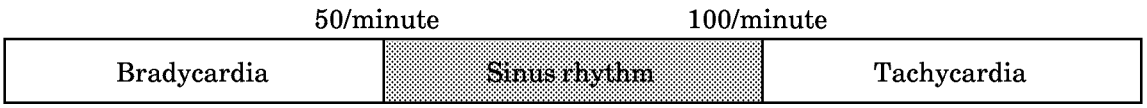
Code	Findings [Criteria]	Judgement
1100	Sinus rhythm	normal ECG
1120	Sinus tachycardia	abnormal rhythm ECG
1130	Sinus bradycardia	abnormal ECG

◆Analysis criteria

Findings	Criteria
Sinus rhythm	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular (3) $-30° \leqq$ P axis $< 120°$ (4) $50 \leqq$ heart rate < 100*
Sinus tachycardia	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular (3) $-30° \leqq$ P axis $< 120°$ (4) $100 \leqq$ heart rate*
Sinus bradycardia	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular (3) $-30° \leqq$ P axis $< 120°$ (4) $50 >$ heart rate*

NOTE

The values marked with "*" vary with age. For details, refer to p. 6-0-6.

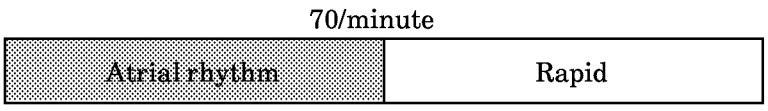


●Atrial

Code	Findings [Criteria]	Judgement
1200	Atrial rhythm	abnormal rhythm ECG
1220	Rapid atrial rhythm	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Atrial rhythm	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular (3) ① ① 120° ≦ P axis ≦ 240° ② −30° > P axis ≧ −60° ② (1) PR interval > 0.14 s (2) ① 120° ≦ P axis ≦ 270° ② −30° > P axis ≧ −90° (4) Heart rate ≦ 70
Rapid atrial rhythm	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular (3) ① ① 120° ≦ P axis ≦ 240° ② −30° > P axis ≧ −60° ② (1) PR interval > 0.14 s (2) ① 120° ≦ P axis ≦ 270° ② −30° > P axis ≧ −90° (4) 70 < heart rate

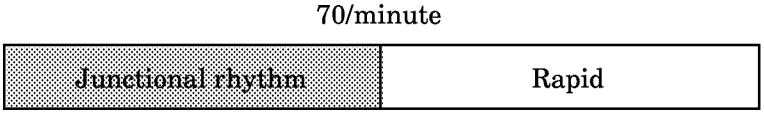


●AV junction

Code	Findings [Criteria]	Judgement
1300	Junctional rhythm	abnormal rhythm ECG
1320	Rapid junctional rhythm	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Junctional rhythm	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular PR ≦ 0.14 s (3) ① −60° > P axis > −90° ② 240° < P axis ≦ 270° (4) Heart rate ≦70
Rapid junctional rhythm	(1) Electronic atrial pacemaker is not used. (2) P waveform; constant, PR interval; regular PR ≦ 0.14 s (3) ① −60° > P axis > −90° ② 240° < P axis ≦ 270° (4) 70 < heart rate (age >3 years) 80 < heart rate (age ≦3 years)



(2) Without P wave

●Without atrial fibrillation or without atrial flutter

Code	Findings [Criteria]	Judgement
1400	Undetermined rhythm (Possible supraventricular rhythm)	abnormal rhythm ECG
1420	Undetermined rhythm (Possible supraventricular tachycardia)	abnormal rhythm ECG
1430	Undetermined rhythm (Possible supraventricular bradycardia)	abnormal rhythm ECG

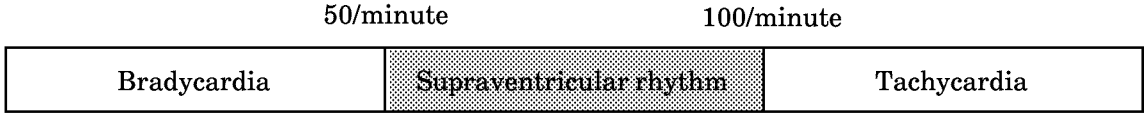
◆ Analysis criteria

When the P wave is not joined to the QRS, the following criteria are used for classification.

Findings	Criteria
Undetermined rhythm (Possible supraventricular rhythm)	(1) Electronic atrial pacemaker is not used. (2) Atrial fibrillation and atrial flutter are not present. (3) QRS duration $<$ 120 ms* (4) 50 $\leqq$ heart rate $<$ 100*
Undetermined rhythm (Possible supraventricular tachycardia)	(1) Electronic atrial pacemaker is not used. (2) Atrial fibrillation and atrial flutter are not present. (3) QRS duration $<$ 120 ms* (4) heart rate $\geqq$ 100*
Undetermined rhythm (Possible supraventricular bradycardia)	(1) Electronic atrial pacemaker is not used. (2) Atrial fibrillation and atrial flutter are not present. (3) QRS duration $<$ 120 ms* (4) heart rate $<$ 50*

NOTE

- The values marked with "*" vary with age. For details, refer to p. 6-0-2 and 6-0-6.
- When these findings are recognized, other less important findings are not printed on the recording paper.



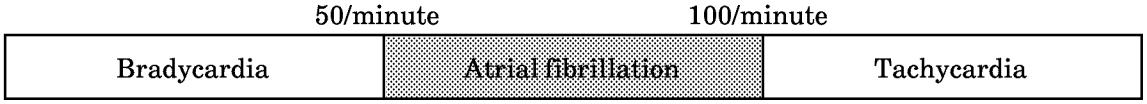
●With atrial fibrillation or with atrial flutter

Code	Findings [Criteria]	Judgement
1210	Atrial fibrillation	abnormal rhythm ECG
12101	Atrial fibrillation with rapid ventricular response	abnormal rhythm ECG
12102	Atrial fibrillation with slow ventricular response	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Atrial fibrillation	(1) P wave is not present. (2) RR interval deviation > 0.125 × mean RR interval (3) Random RR interval (4) 50 ≦ heart rate < 100*
Atrial fibrillation with rapid ventricular response	(1) P wave is not present. (2) RR interval deviation > 0.125 × mean RR interval (3) Random RR interval (4) 100 ≦ heart rate*
Atrial fibrillation with slow ventricular response	(1) P wave is not present. (2) RR interval deviation > 0.125 × mean RR interval (3) Random RR interval (4) 50 > heart rate *

NOTE
The values marked with "*" vary with age. For details, refer to p. 6-0-6.



Code	Findings [Criteria]	Judgement
1250	Atrial flutter	abnormal rhythm ECG
12505	Cannot rule out atrial flutter	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Atrial flutter	(1) F wave is detected
Cannot rule out atrial flutter	(1) P wave is not present. (2) 140 ≦ heart rate ＜ 155 (3) Age ＞ 2

(3) With pacemaker

Code	Findings [Criteria]	Judgement
16006	Electronic atrial pacemaker	atypical ECG
16007	Electronic ventricular pacemaker	atypical ECG
16008	Electronic atrial pacemaker (Unreliable analysis due to noise)	atypical ECG
16009	Electronic ventricular pacemaker (Unreliable analysis due to noise)	atypical ECG

◆Analysis criteria

Findings	Criteria
Electronic atrial pacemaker rhythm	(1) QRS is dominant waveform. (2) Pacemaker pulse recognized within 0.08 s before and after the beginning of the P wave (3) Three or more heartbeats satisfying above two conditions are present.
Electronic ventricular pacemaker rhythm	Pacemaker pulse and dominant QRS are joined.

NOTE

- When there is any detached electrode or noise during analysis, “16008” or “16009” appear in the findings column even if the above conditions are satisfied.

- If spontaneous systoles occur during ECG observation, the ECG system analyzes the spontaneous systoles. In this case, “0201 Contour analysis based on intrinsic rhythm” is additionally printed out in the findings column.

2. Basic rhythm fluctuation analysis

Code	Findings [Criteria]	Judgement
1901	Undetermined regular rhythm	atypical ECG
1902	Undetermined rhythm	atypical ECG
1921	Undetermined regular rhythm (tachycardia)	atypical ECG
1922	Undetermined rhythm (tachycardia)	atypical ECG
1931	Undetermined regular rhythm (bradycardia)	atypical ECG
1932	Undetermined rhythm (bradycardia)	atypical ECG

◆Analysis criteria

Findings	Criteria
Undetermined regular rhythm	(1) Normal P wave is not present. (2) QRS duration ≧ 0.12 s* (3) Atrial fibrillation is not present. (4) Atrial flutter is not present. (5) Electronic pacemaker is not used. (6) All QRSs are dominant type. (7) Maximum RR interval − Minimum RR interval < 1/8 mean RR interval
Undetermined rhythm	(1) Normal P wave is not present. (2) QRS duration ≧ 0.12 s* (3) Atrial fibrillation is not present. (4) Atrial flutter is not present. (5) Electronic pacemaker is not used. (6) Regular rhythm is not present.
Undetermined regular rhythm (tachycardia)	(1) Cannot determine the rhythm (PR interval; regular) (2) 100* ≦Heart rate
Undetermined rhythm (tachycardia)	(1) Cannot determine the rhythm (2) 100* ≦Heart rate
Undetermined regular rhythm (bradycardia)	(1) Cannot determine the rhythm (PR interval; regular) (2) 50* >Heart rate
Undetermined rhythm (bradycardia)	(1) Cannot determine the rhythm (2) 50* >Heart rate

NOTE
The values marked with "*" vary with age. For details refer to p. 6-0-2 and 6-0-6.

Code	Findings [Criteria]	Judgement
1938	Extreme bradycardia	atypical ECG

◆Analysis criteria

Findings	Criteria
Extreme bradycardia	(1) 40 > Heart rate (2) 2° AV block (Mobitz type Ⅱ) is not present.

●With abnormal rhythm

Code	Findings [Criteria]	Judgement
1002	Marked rhythm irregularity, possible non-conducted PAC, SA block, AV block, or sinus pause	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Marked rhythm irregularity, possible non-conducted PAC, SA block, AV block or sinus pause	(1) 2° AV block is not present. (2) Heart rate < 100 (3) Random RR interval

Code	Findings [Criteria]	Judgement
1102	Sinus arrhythmia	normal ECG
1108	Marked sinus arrhythmia	normal ECG

◆ Analysis criteria

When sinus rhythm, sinus tachycardia and sinus bradycardia are judged and satisfy the below conditions, then the classification is as below.

Findings	Criteria
Sinus arrhythmia	(1) Premature complexes are not present. (2) Marked rhythm irregularity is not present. (3) RR interval deviation $>$ 0.2 $\times$ mean RR interval
Marked sinus arrhythmia	(1) Premature complexes are not present. (2) Marked rhythm irregularity is not present. (3) RR interval deviation $>$ 0.4 $\times$ mean RR interval

NOTE

"Premature complexes: absent" and "Marked rhythm irregularity: absent" are analyzed according to their analysis criteria on p. 6-1-12, 6-1-13, 6-1-14 and 6-1-15.

3. Premature complex analysis

(1) Supraventricular

Code	Findings [Criteria]	Judgement
1470	with occasional supraventricular premature complexes	abnormal rhythm ECG
1474	with frequent supraventricular premature complexes	abnormal rhythm ECG
1475	with frequent supraventricular premature complexes in a pattern of bigeminy	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
with occasional supraventricular premature complexes	(1) Intermittent WPW is not present. (2) 2° AV block is not present. (3) Marked rhythm irregularity is not present. (4) ① RR interval < mean RR interval × 3/4 ② ● P wave is not sinus-induced. ● RR interval < mean RR interval − 0.10 s
with frequent supraventricular premature complexes	Three or more supraventricular premature complexes given above and/or ectopic premature complexes are present.
with frequent supraventricular premature complexes in a pattern of bigeminy	Supraventricular premature complexes given above and dominant waveform appear alternately.

(2) Ventricular

Code	Findings [Criteria]	Judgement
1570	with occasional ventricular premature complexes	abnormal rhythm ECG
1574	with frequent ventricular premature complexes	abnormal rhythm ECG
1575	with frequent ventricular premature complexes in a pattern of bigeminy	abnormal rhythm ECG
1577	with couplet ventricular premature complexes	abnormal rhythm ECG
15708	with occasional ventricular premature complexes (Unreliable analysis due to noise)	abnormal rhythm ECG
15748	with frequent ventricular premature complexes (Unreliable analysis due to noise)	abnormal rhythm ECG
15758	with frequent ventricular premature complexes in a pattern of bigeminy (Unreliable analysis due to noise)	abnormal rhythm ECG
15778	with couplet ventricular premature complexes (Unreliable analysis due to noise)	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
with occasional ventricular premature complexes	(1) Intermittent WPW is not present. (2) Ectopic QRS duration > 0.12 s* ① for heartbeats from 2nd onward: ● P wave does not precede QRS-complex ● RR interval + 0.04 s < mean RR interval ② for heartbeats from 2nd onward: ● P wave precedes QRS-complex ● RR interval + 0.10 s < mean RR interval ③ for the first heartbeat: ● P wave does not precede QRS-complex ● next RR interval − 0.04 s > mean RR interval ④ for the first heartbeat: ● P wave precedes QRS-complex ● next RR interval − 0.10 s > mean RR interval
with frequent ventricular premature complexes	Three or more ventricular premature complexes given above are present.
with frequent ventricular premature complexes in a pattern of bigeminy	The ventricular premature complexes given above and dominant waveform appear alternately.
Couplet ventricular premature complexes	More than two ventricular premature complexes given above appear consecutively.

NOTE

- When any of above conditions is satisfied and there is any electrode detached or noise exists during analysis, "15708", "15748", "15758", or "15778" appears in the finding column.
- The value marked with "*" varies with age. For details, refer to p. 6-0-2.

(3) Ectopic

Code	Findings [Criteria]	Judgement
1970	with occasional ectopic premature complexes	abnormal rhythm ECG
1974	with frequent ectopic premature complexes	abnormal rhythm ECG
1975	with frequent ectopic premature complexes in a pattern of bigeminy	abnormal rhythm ECG
19708	with occasional ectopic premature complexes (Unreliable analysis due to noise)	abnormal rhythm ECG
19748	with frequent ectopic premature complexes (Unreliable analysis due to noise)	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
with occasional ectopic premature complexes	(1) Satisfies all criteria for ventricular premature complexes other than ectopic QRS (2) 0.06 s $<$ ectopic QRS duration $\leqq$ 0.12 s
with frequent ectopic premature complexes	Three or more ectopic premature complexes given above are present.
with frequent ectopic premature complexes in a pattern of bigeminy	Above occasional ectopic premature complexes and dominant waveform appear alternately.

NOTE

- When either the conditions 1970 or 1974 is satisfied and there is any electrode detached or noise exists during analysis, “19708” or “19748” appears in the finding column.
- Ectopic premature complexes do not appear in the finding column when it is judged together with the occasional supraventricular premature complexes. This is because the instrument judges it to be occasional supraventricular premature complexes with abberant conduction.

(4) With atrial fibrillation or with atrial flutter

Code	Findings [Criteria]	Judgement
12103	Atrial fibrillation with aberrant conduction, or ventricular premature complexes	abnormal rhythm ECG
12108	Atrial fibrillation with rapid ventricular response with aberrant conduction, or ventricular premature complexes	abnormal rhythm ECG
12109	Atrial fibrillation with slow ventricular response with aberrant conduction, or ventricular premature complexes	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Atrial fibrillation with aberrant conduction, or ventricular premature complexes	(1) Atrial fibrillation is present. (2) Ectopic QRS is not pacemaker waveform (3) Ectopic QRS with interval ≧ 0.12 s*
Atrial fibrillation with rapid ventricular response with aberrant conduction, or ventricular premature complexes	(1) Atrial fibrillation with rapid ventricular response is present. (2) Ectopic QRS is not pacemaker waveform (3) Ectopic QRS with interval ≧ 0.12 s*
Atrial fibrillation with slow ventricular response with aberrant conduct, or ventricular premature complexes	(1) Atrial fibrillation with slow ventricular response is present. (2) Ectopic QRS is not pacemaker waveform (3) Ectopic QRS with interval ≧ 0.12 s*

NOTE

- For “Atrial fibrillation”, “Atrial fibrillation with rapid ventricular response” and “Atrial fibrillation with slow ventricular response”, the same analysis criteria given on p. 6-1-5 are used.
- The values marked with “*” vary with age. For details, refer to p. 6-0-2.

Code	Findings [Criteria]	Judgement
12503	Atrial flutter with aberrant conduction, or ventricular premature complexes	abnormal rhythm ECG

◆Analysis criteria

Findings	Criteria
Atrial flutter with aberrant conduction, or ventricular premature complexes	(1) Atrial flutter is present. (2) Ectopic QRS is not pacemaker waveform (3) Ectopic QRS with interval ≧ 0.12 s*

NOTE

- For "Atrial flutter", the same analysis criteria given on p. 6-1-6 is used.
- The value marked with "*" varies with age. For details, refer to p. 6-0-2.

6-2 Conductive Defect

2210	Short PR interval	6-2-1
2216	Type-A Wolff-Parkinson-White syndrome	6-2-2
2217	Type-B Wolff-Parkinson-White syndrome	6-2-2
2218	Atypical Wolff-Parkinson-White syndrome	6-2-2
2219	Intermittent Wolff-Parkinson-White syndrome	6-2-2
2231	First degree AV block	6-2-4
2232	2nd degree AV block, Mobitz type I	6-2-4
2233	2nd degree AV block, Mobitz type II	6-2-4
2234	Possible 3rd degree AV block	6-2-4
2320	Nonspecific intraventricular conduction delay	6-2-9
2330	Nonspecific intraventricular conduction block	6-2-9
2420	RSR (QR) in lead V1/V2, consistent with right ventricular conduction delay	6-2-5
2440	Incomplete right bundle branch block	6-2-5
2450	Right bundle branch block	6-2-5
24501	Right bundle branch block, plus possible RVH	6-2-5
2540	Incomplete left bundle branch block	6-2-7
2550	Left bundle branch block	6-2-7
2630	Left anterior fascicular block	6-2-8
2730	Left posterior fascicular block	6-2-8

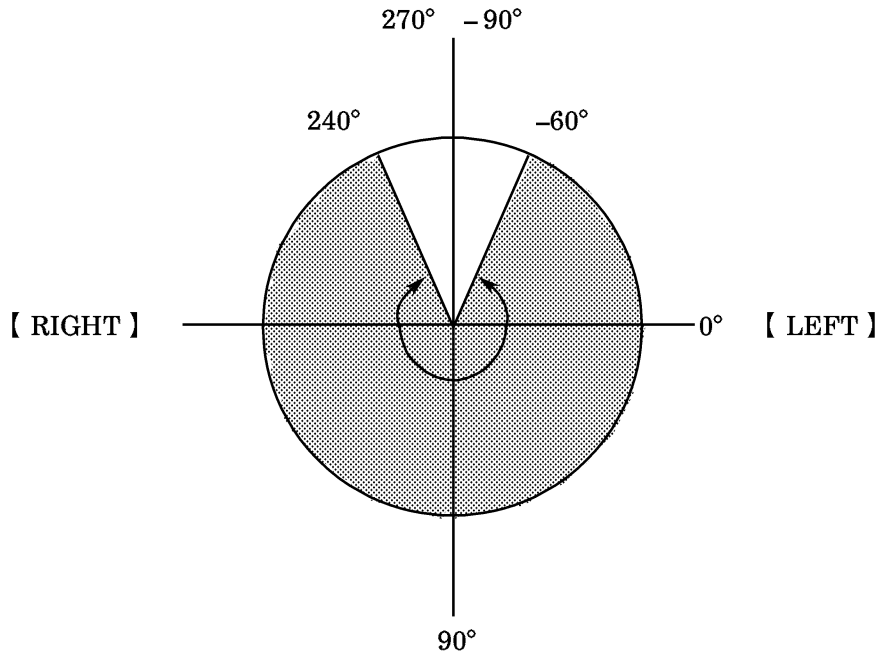
1. A-V conductive defect

Code	Findings [Criteria]	Judgement
2210	Short PR interval	atypical ECG

◆Analysis criteria

Findings	Criteria
Short PR interval	(1) Pacemaker is not used. (2) P waveform and PR interval are both constant. (3) $-60° \leqq$ P axis $\leqq 240°$ (4) PR interval < 0.12 s *

NOTE
The value marked with "*" varies with age. Refer to p. 6-0-1.



●Wolff-Parkinson-White syndrome

Code	Findings [Criteria]	Judgement
2216	Type-A Wolff-Parkinson-White syndrome	abnormal ECG
2217	Type-B Wolff-Parkinson-White syndrome	abnormal ECG
2218	Atypical Wolff-Parkinson-White syndrome	abnormal ECG
2219	Intermittent Wolff-Parkinson-White syndrome	abnormal ECG

◆Analysis criteria

Findings	Criteria
Type-A WPW syndrome	(1) ① ● PR interval ≦ 0.12 s* ● Delta waves are recognized in at least two leads. ② ● PR interval ≦ 0.14 s* ● Delta waves are recognized in at least three leads. ③ Delta waves are recognized in at least five leads. ④ ● PR interval ≦ 0.12 s* ● Q wave is not present and VAT > 0.08 s in at least two leads (2) Maximum R amplitude > Maximum S amplitude in V1
Type-B WPW syndrome	(1) ① ● QRS area ratio > 0.4 in at least two leads among I, V5 and V6 ● R duration > 0.03 s in V2 ● PR interval ≦ 0.14 s* ② ● PR interval ≦ 0.12 s* ● Delta waves are recognized in at least two leads. ③ ● PR interval ≦ 0.14 s* ● Delta waves are recognized in at least three leads. ④ Delta waves are recognized in at least five leads. ⑤ ● PR interval ≦ 0.12 s* ● Q wave is not present and VAT > 0.08 s in at least two leads (2) Maximum R amplitude ≦ Maximum S amplitude in V1
Atypical WPW syndrome	① ● PR interval ≦ 0.12 s* ● Delta waves are recognized in at least two leads. ② ● PR interval ≦ 0.14 s* ● Delta waves are recognized in at least three leads. ③ Delta waves are recognized in at least five leads. ④ ● PR interval ≦ 0.12 s* ● Q wave is not present and VAT > 0.08 s in at least two leads
Intermittent WPW syndrome	(1) Four or more ectopic QRS without pacemaker pulses are present. (2) Heart rate < 120 (3) RR interval of the ectopic beat + 0.16 s > RR interval of dominant beat (4) Delta waves are recognized in at least two leads (5) PR interval of the ectopic beat < 0.14 s * (6) PR interval of the ectopic beat < Mean PR interval of the dominant QRS − 0.02 s (7) PJ interval of the ectopic beat > PJ interval of the dominant QRS − 0.02 s

NOTE

(1) If any of the following is satisfied, WPW check is not done.
   ① P wave is not the same type as the dominant beat's.
   ② PR interval > 0.17 s *
   ③ QRS duration < 0.10 s *
   ④ QRS duration > 0.20 s *
   ⑤ Heart rate > 120 *
(2) If WPW is determined by the above analysis criteria, other waveform analysis will be omitted.
(3) The values marked with "*" vary with age. Refer to p. 6-0-1, 6-0-2 and 6-0-6.
(4) PJ interval is the time between the starting point of P wave to the end point of QRS wave (STJ point).

●AV block

Code	Findings [Criteria]	Judgement
2231	First degree AV block	abnormal ECG
2232	2nd degree AV block, Mobitz type I	abnormal ECG
2233	2nd degree AV block, Mobitz type II	abnormal ECG
2234	Possible 3rd degree AV block	abnormal ECG

◆Analysis criteria

Findings	Criteria
First degree AV block	(1) No pacemaker is used. (2) P waveform and PR interval are both constant (3) $-60° \leqq$ P axis $\leqq 240°$ (4) PR interval $\geqq$ 0.21 s
2nd degree AV block, Mobitz type I	(1) 2nd degree AV block (Mobitz type II) is not present. (2) Both the preceding and current heartbeats are in dominant waveform. (3) QRS dropout (which is characteristic of Mobitz type I) exists which is calculated from RR interval.
2nd degree AV block, Mobitz type II	QRS dropout (which is characteristic of Mobitz type II) exists which is calculated from RR interval.
Possible 3rd degree AV block	(1) P wave is not present. (2) Heart rate < 50 (3) Differences between RR intervals are less than 2% of the mean RR interval

2. Intra-ventricular conductive defect

●Right bundle branch block

Code	Findings [Criteria]	Judgement
2420	RSR (QR) in lead V1/V2 consistent with right ventricular conduction delay	borderline ECG
2440	Incomplete right bundle branch block [90＋ms QRS duration, terminal R in lead V1/V2, 40＋ms S in 2 leads among I, aVL, V4, V5, V6]	borderline ECG
2450	Right bundle branch block [120＋ms QRS duration, upright V1, 40＋ms S in 2 leads among I, aVL, V4, V5, V6]	abnormal ECG
24501	Right bundle branch block, plus possible RVH [RBBB, 1.5mV R in V1, RAD]	abnormal ECG

◆Analysis criteria

Findings	Criteria
RSR (QR) in lead V1/V2 consistent with right ventricular conduction delay	In V1 or V2 ① ● R amplitude > 0.1 mV ● R duration > 0.02 s * ● S wave is not presnt. ② ● R' amplitude > 0.1 mV ● R' duration > 0.02 s *
Incomplete right bundle branch block	(1) 0.09 s < QRS duration < 0.12 s * (2) In two leads among I, aVL, V4, V5 and V6, S duration ≧ 0.04 s* (3) Right ventricular conduction delay is present.
Right bundle branch block	(1) QRS duration ≧ 0.12 s * (2) QRS area > 0 in V1 (3) S duration > 0.04 s * in 2 or more leads among I, aVL, V4, V5, V6 (4) R duration < 0.10 s * in 4 or more leads among I, aVL, V4, V5, V6 (5) Does not end with S or S' wave in V1 Or (1) QRS duration ≧ 0.105 s * (2) S duration > 0.06 s * in 3 or more leads among I, aVL, V4, V5, V6 (3) R or R' duration > 0.06 s * in V1 (4) QRS area > 0 in V1

Findings	Criteria
Right bundle branch block, plus possible RVH	(1) RBBB is present. (2) ① ● Age ≧ 1 year old ● R or R' amplitude > 1.5 mV in V1 ② R or R' amplitude > 2.0 mV in V1 (3) 110° < QRS axis ≦ 270° (>14 years old) 120° < QRS axis ≦ 270° (≦14 years old)

NOTE

- The values marked with "*" vary with age. Refer to p. 6-0-2 and 6-0-3.
- When RBBB is recognized, no right axis deviation is judged.
- With right bundle branch conduction defects, the terminating vector is directed towards the anterior and right and it is extended. In the ECAPS 12C criteria, not only QRS duration but also the presence of R at V1, and of wide S in at least two lateral leads are required.
- Previously, QRS duration over 0.12 second was a criterion for bundle branch blocks. However, since QRS duration over 0.105 second with wide S in the lateral leads and wide R in V1 appearing is also judged as RBBB, this case has been included in the ECAPS 12C program.

●Left bundle branch block

Code	Findings [Criteria]	Judgement
2540	Incomplete left bundle branch block [105 + ms QRS duration, 80 + ms Q/S in lead V1/V2, no Q in 2 leads among I, V5, V6 and 60 + ms R in 2 leads among I, aVL, V5, V6]	abnormal ECG
2550	Left bundle branch block [120 + ms QRS duration, 80 + ms Q/S in lead V1/V2, 250 + ms R (sum) in lead I/aVL/V6]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Incomplete left bundle branch block	(1) QRS duration > 0.105 s * (2) Net QRS amplitude < 0 in V1, V2 (3) Q/S duration ≧ 0.080 s * in V1, V2 (4) Q wave is not present in at least 2 leads among I, V5, V 6 (5) R duration ≧ 0.060 s * in at least 2 leads among I, aVL, V5, V6
Left bundle branch block	(1) Incomplete LBBB is present. (2) R + R' duration ≧ 0.1 s * in any leads among I, aVL, V6 (3) QRS area ratio > 0.25 in I or V6 (4) ① QRS duration ≧ 0.16 s * ② ● QRS duration ≧ 0.14 s * ● total of each R + R' duration≧ 0.25 s * in I, aVL, V6 ③ ● QRS duration ≧ 0.12 s * ● total of each R + R' duration≧ 0.25 s * in I, aVL, V6 ● QRS area ratio > 0.4 in at least 2 leads among I, aVL, V6

NOTE

- The values marked with "*" vary with age. Refer to p. 6-0-2 and 6-0-3.
- When "incomplete LBBB" is judged, "Moderate level left axis deviation" is not printed out.
- When "LBBB" is judged, "Moderate level left axis deviation", "Left anterior fascicular block", and "Left posterior fascicular block" are not printed out.
- QRS area in the analysis criteria for LBBB means the area from the start to the end of QRS. Refer to p. 3-7 (b). This area increases through R type, expansion, notch, etc. Therefore, the boundary values are determined on the basis of typical LBBB cases. This value is used instead of R wave to classify between the true LBBB and R pattern where R wave is expanded by nonspecific slur at the end of the wave.
- There is no specific definition for incomplete LBBB in ECG analysis. In the ECAPS 12C program, incomplete LBBB is defined very narrowly, and whenever other findings are applicable, such as left posterior fascicular block, then one of those findings is taken.

●Fascicular block

Code	Findings [Criteria]	Judgement
2630	Left anterior fascicular block [QRS axis ≦ −45, QR in I, RS in II]	abnormal ECG
2730	Left posterior fascicular block [QRS axis > 109, inferior Q]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Left anterior fascicular block	(1) − 90° <QRS axis ≦ −45° (2) R amplitude > Q amplitude in I and aVL (3) Q wave is present in I (4) S or S' amplitude > maximum R amplitude in II
Left posterior fascicular block	(1) Age ≧ 1 year old (2) S pattern is not present. (3) Right atrial enlargement is not present. (4) Lung disease is not recognized. (5) 110° ≦ QRS axis ≦ 270° (> 14 years old) 120° ≦ QRS axis ≦ 270° (≦ 14 years old) (6) R amplitude > Q amplitude (III and aVF) (7) Q wave is present (III and aVF).

NOTE

- When "Left anterior fascicular block" is judged, "Moderate left axis deviation" and "Left axis deviation" are not printed out.
- When "Left posterior fascicular block" is judged, "Moderate right axis deviation" and "Right axis deviation" are not printed out.

●Nonspecific

Code	Findings [Criteria]	Judgement
2320	Nonspecific intraventricular conduction delay [110 + ms QRS duration]	borderline ECG
2330	Nonspecific intraventricular conduction block [130 + ms QRS duration]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Nonspecific intraventricular conduction delay	(1) Block-related findings are not present. (2) QRS duration > 0.11 s *
Nonspecific intraventricular conduction block	(1) Criteria for RBBB and LBBB are not satisfied. (2) QRS duration > 0.13 s *

NOTE

- The values marked with "*" vary with age. Refer to p. 6-0-2.
- Intraventricular conduction delay is judged when the criteria on p. 6-2-4 to 6-2-7 are not satisfied, and QRS duration is not large enough to be judged as blocks.

6-3 Myocardial Infarction

Analysis Criteria 6-3-1

Anterior Myocardial Infarction 6-3-4

Septal Myocardial Infarction 6-3-8

Lateral Myocardial Infarction 6-3-10

Inferior Myocardial Infarction 6-3-12

Children 6-3-15

Analysis Criteria

Myocardial infarction arises from the stricture and obstruction of coronary arteries and death of heart muscles. It is mainly caused by coronary arteriosclerosis. It is said that myocardial infarction shows a characteristic ECG waveform.

1. **Features and analysis method of ECG of myocardial infarction**
   The Q wave duration is commonly taken as the main factor for judging the presence of myocardial infarction and likewise, ECAPS 12C also checks the Q wave duration. In addition to Q wave duration, repolarization abnormality that is sometimes reported to accompany "acute" or "recent" cases of myocardial infarction is also considered to be useful in detecting myocardial infarction. For example, elevated ST junctions and negative T waves are very clear signs of myocardial infarction, even when significant Q waves are absent.

   When abnormal repolarization is taken into consideration, both the sensitivity and discrimination level of analysis are improved for acute and recent cases. For old cases, observing the QRS amplitude and duration improves the analysis precision.
   With this program, these factors are integrated into "equivalent Q duration" for analysis processing.

   The use of this new factor does not differ greatly from conventional analysis. It measures and processes age, sex, Q duration, Q amplitude QRS duration and QRS amplitude as a whole to improve the precision level of analysis. This "equivalent Q duration" is used in the analysis criteria unless stated otherwise.

The ECAPS 12C analysis program classifies ECGs for myocardial infarction diagnostic purposes as follows:

Item	Division	Criteria	Description
Age classification	Acute (?)	ST elevation	Varies with the extent of ST elevation
	Recent (?)		
	Old (?)	No ST elevation	
	Age undetermined	Age cannot be determined.	
Level classification	Determined	Equivalent Q duration: 40 ms ~	Classified by eq. Q duration (Eq. Q duration is one corrected for Q amp., R amp. and QRS duration.)
	Possible	35 ~ 39 ms	
	Cannot rule out	30 ~ 34 ms	

(1) Age classification

It is said that after the occurrence of myocardial infarction, the T wave increases height and ST elevates within several hours, and then, with some delay, abnormal Q waves appear. It is also said that the coronary T wave starts to appear while the ST elevation is improving (2 days to 1 week) and remains for a long period of time. Although the time division, "acute (?)", "recent (?)", "age undetermined" and "old (?)", is classified according to the ST elevation level, this is a classification of ECG diagnosis, not a clinical diagnosis.
In atypical instances, ST elevation may be observed for more than a few months.

(2) Level classification

Abnormal Q wave is the most important factor in identifying myocardial infarction. The divisions "determined", "possible" and "cannot rule out" given here according to the durations of abnormal Q waves are the terms expressing the level of definiteness of the ECG features or the level of computer analysis, and they are not directly related to the level of seriousness in clinical diagnosis.

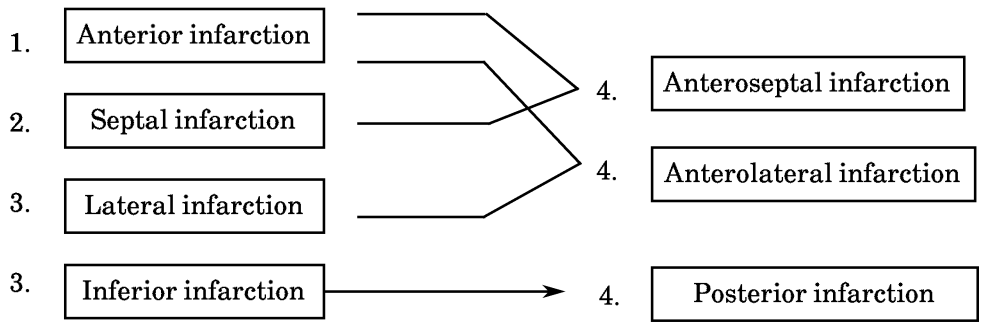
2. Diagnosis of infarct portion by abnormal Q wave

The locations of infarction are classified according to the leads showing abnormal Q waves:

	Ⅰ	Ⅱ	Ⅲ	aVR	aVL	aVF	V1	V2	V3	V4	V5	V6
Anterior								∨	∨	∨	∨	
Septal							Δ[1]	∨				
Lateral	∨				∨						∨	∨
Inferior		∨				∨						
Posterior inferior		∨				∨	Δ[2]	Δ[2]				
Anterolateral	∨				∨			∨	∨	∨	∨	
Anteroseptal							Δ[1]	∨	∨	∨	∨	

1: Q wave is present 2: By R duration

The program analyzes the infarct portions in the following sequence:



3. Other features

(1) Abnormal Q waves may appear in cases of "LBBB", "WPW syndrome", "pulmonary embolism", "LVH", and "RVH".

(2) Sometimes the characteristic ECG of infarction does not appear at all depending on the time after the nosogenesis, the size and portion of the infarction. Clinical reviews including chemical blood tests (GOT, GPT, LDH, CPK) are recommended.

(3) An intermixed EMG or AC noise is sometimes mistaken for small R waves. This program is designed to use the typical heartbeat waves that contain Q waves with priority among all typical heartbeat waves, but record favorable waveforms by eliminating artifact as much as possible.

Anterior Myocardial Infarction

When the following criteria are satisfied, anterior myocardial infarction is not analyzed.

- LBBB
- QRS duration > 140 ms, negative net QRS amplitude at V1

◆Analysis criteria

Age classification	Criteria	Other
Acute (?)	STM > 0.2 mV in V3 and V4 and STE > 0.2 mV in V3 and V4 and Modified T amplitude ≧ 0 * in V3 and V4	
Recent (?)	STM > 0.05 mV in V3 or V4 and STE > 0.05 mV in same leads as above and Modified T amplitude < 0* in V3 or V4	
Old (?)	STM < 0.03 mV in V3 and V4 and Modified T amplitude ≧ 0* in V3 and V4	Acute (?) and Recent (?) are not satisfied.
Age undetermined	Acute (?), Recent (?) and Old (?) are not satisfied.	

* Refer to p. 3-7(d) for measurement method.

Level classification	Criteria	Other
Cannot rule out	Q duration ≧ 30 ms in V2 and V3, or V3 and V4, or V4 and V5 or R amplitude < 0.2 mV in V4	
Possible	Q duration ≧ 30 ms in V2 or V4 and Q duration ≧ 35 ms in V3 or Q duration ≧ 30 ms in V3 or V5 and Q duration ≧ 35 ms in V4	LVH is not present.
(Determined)	Q duration ≧ 30 ms in V2 or V4 and Q duration ≧ 40 ms in V3 or Q duration ≧ 30 ms in V3 or V5 and Q duration ≧ 40 ms in V4 or "Cannot rule out" is satisfied	LVH is not present. Chest lead low voltage is not present. Nonspecific intraventricular conduction block is not present. Acute (?) or Recent (?) is satisfied.

◆ Code and findings

Code	Findings [Criteria]	Judgement
3113	Cannot rule out anterior myocardial infarction, probably old [30 ms Q wave in lead V3/V4 or R < 0.2 mV in V4]	abnormal ECG
3114	Cannot rule out anterior myocardial infarction, age undetermined [30 ms Q wave in lead V3/V4 or R < 0.2 mV in V4]	abnormal ECG
3121	Possible anterior myocardial infarction, possibly acute [35 ms Q wave in lead V3/V4]	abnormal ECG
3122	Possible anterior myocardial infarction, probably recent [35 ms Q wave in lead V3/V4]	abnormal ECG
3123	Possible anterior myocardial infarction, probably old [35 ms Q wave in lead V3/V4]	abnormal ECG

Code	Findings [Criteria]	Judgement
3124	Possible anterior myocardial infarction, age undetermined [35 ms Q wave in lead V3/V4]	abnormal ECG
3131	Anterior myocardial infarction, possibly acute [40＋ms Q wave in lead V3/V4]	abnormal ECG
3132	Anterior myocardial infarction, probably recent [40＋ms Q wave in lead V3/V4]	abnormal ECG
3133	Anterior myocardial infarction, probably old [40＋ms Q wave in lead V3/V4]	abnormal ECG
3134	Anterior myocardial infarction, age undetermined [40＋ms Q wave in lead V3/V4]	abnormal ECG
3213	Cannot rule out anteroseptal myocardial infarction, probably old [30 ms Q wave in lead V2＋V3/V4]	abnormal ECG
3214	Cannot rule out anteroseptal myocardial infarction, age undetermined [30 ms Q wave in lead V2＋V3/V4]	abnormal ECG
3221	Possible anteroseptal myocardial infarction, possibly acute [35 ms Q wave in lead V2＋V3/V4]	abnormal ECG
3222	Possible anteroseptal myocardial infarction, probably recent [35 ms Q wave in lead V2＋V3/V4]	abnormal ECG
3223	Possible anteroseptal myocardial infarction, probably old [35 ms Q wave in lead V2＋V3/V4]	abnormal ECG
3224	Possible anteroseptal myocardial infarction, age undetermined [35 ms Q wave in lead V2＋V3/V4]	abnormal ECG
3231	Anteroseptal myocardial infarction, possibly acute [40＋ ms Q wave in lead V2＋V3/V4]	abnormal ECG
3232	Anteroseptal myocardial infarction, probably recent [40＋ ms Q wave in lead V2＋V3/V4]	abnormal ECG
3233	Anteroseptal myocardial infarction, probably old [40＋ ms Q wave in lead V2＋V3/V4]	abnormal ECG
3234	Anteroseptal myocardial infarction, age undetermined [40＋ ms Q wave in lead V2＋V3/V4]	abnormal ECG

Code	Findings [Criteria]	Judgement
3313	Cannot rule out anterolateral myocardial infarction, probably old [30 ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3314	Cannot rule out anterolateral myocardial infarction, age undetermined [30 ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3321	Possible anterolateral myocardial infarction, possibly acute [35 ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3322	Possible anterolateral myocardial infarction, probably recent [35 ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3323	Possible anterolateral myocardial infarction, probably old [35 ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3324	Possible anterolateral myocardial infarction, age undetermined [35 ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3331	Anterolateral myocardial infarction, possibly acute [40 + ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3332	Anterolateral myocardial infarction, probably recent [40 + ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3333	Anterolateral myocardial infarction, probably old [40 + ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG
3334	Anterolateral myocardial infarction, age undetermined [40 + ms Q wave in lead V3/V4 + 2 leads among I, aVL, V5, V6]	abnormal ECG

Septal Myocardial Infarction

When the following criteria are satisfied, septal myocardial infarction is not analyzed.

- LBBB
- QRS duration > 140 ms and net QRS amplitude is negative in V1.
- Cannot rule out anterior infarction and Q wave is not present in V1

◆Analysis criteria

Age classification	Criteria	Other
Acute (?)	STM and STE > 0.2 mV in V2 and Modified T amplitude ≧ 0* in V2	
Recent (?)	STM and STE > 0.05 mV in V2 and Modified T amplitude < 0* in V2	
Old (?)	STM < 0.05 mV in V2 and Modified T amplitude ≧ 0* in V2	Acute (?) and Recent (?) is satisfied.
Age undetermined	Acute (?), Recent (?) and Old (?) are not satisfied.	

Level classification	Criteria	Other
Cannot rule out	Q duration ≧ 30 ms in V2 or Q duration > 20 ms in V2	RBBB is present.
Possible	Q duration ≧ 35 ms inV2	LVH is not present.
(Determined)	Q duration ≧ 40 ms in V2	LVH is not present.

* Refer to p. 3-7(d) for measurement method.

◆ Code and findings

Code	Findings [Criteria]	Judgement
3411	Cannot rule out septal myocardial infarction, possibly acute [30 ms Q wave in lead V2]	abnormal ECG
3412	Cannot rule out septal myocardial infarction, probably recent [30 ms Q wave in lead V2]	abnormal ECG
3413	Cannot rule out septal myocardial infarction, probably old [30 ms Q wave in lead V2]	abnormal ECG
3414	Cannot rule out septal myocardial infarction, age undetermined [30 ms Q wave in lead V2]	abnormal ECG
3421	Possible septal myocardial infarction, possibly acute [35 ms Q wave in lead V2]	abnormal ECG
3422	Possible septal myocardial infarction, probably recent [35 ms Q wave in lead V2]	abnormal ECG
3423	Possible septal myocardial infarction, probably old [35 ms Q wave in lead V2]	abnormal ECG
3424	Possible septal myocardial infarction, age undetermined [35 ms Q wave in lead V2]	abnormal ECG
3431	Septal myocardial infarction, possibly acute [40+ ms Q wave in lead V2]	abnormal ECG
3432	Septal myocardial infarction, probably recent [40+ ms Q wave in lead V2]	abnormal ECG
3433	Septal myocardial infarction, probably old [40+ ms Q wave in lead V2]	abnormal ECG
3434	Septal myocardial infarction, age undetermined [40+ ms Q wave in lead V2]	abnormal ECG

Lateral Myocardial Infarction

◆Analysis criteria

Age classification	Criteria	Other
Acute (?)	STM and STE > 0.2 mV in V5 and V6 and STM and STE > 0.1 mV in I and aVL and Modified T amplitude ≧ 0* in I, aVL, V5 and V6	
Recent (?)	STM and STE > 0.05 mV in one lead among I, aVL, V5 and V6 and Modified T amplitude < 0* in one lead among I, aVL, V5 and V6	
Old (?)	STM < 0.03 mV in I, aVl, V5 and V6 and Modified T amplitude ≧ 0* in I, aVL, V5 and V6	Acute (?) and Recent (?) are not satisfied.
Age undetermined	Acute (?), Recent (?) and Old (?) are not satisfied.	

Level classification	Criteria	Other
Cannot rule out	Q duration ≧ 30 ms in 2 leads among I, aVL, V5 and V6	
Possible	Q duration ≧ 35 ms in one lead among I, V5 and V6	Cannot rule out is satisfied.
(Determined)	Q duration ≧ 40 ms in one lead among I, V5 and V6 or Cannot rule out	Cannot rule out is satisfied. Acute (?) and Recent (?) are satisfied.

* Refer to p. 3-7(d) for measurement method.

◆ Code and findings

Code	Findings [Criteria]	Judgement
3513	Cannot rule out lateral myocardial infarction, probably old [30 ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3514	Cannot rule out lateral myocardial infarction, age undetermined [30 ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3521	Possible lateral myocardial infarction, possibly acute [35 ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3522	Possible lateral myocardial infarction, probably recent [35 ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3523	Possible lateral myocardial infarction, probably old [35 ms Q wave in 2 leads I/aVL/V5/V6]	abnormal ECG
3524	Possible lateral myocardial infarction, age undetermined [35 ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3531	Lateral myocardial infarction, possibly acute [40+ ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3532	Lateral myocardial infarction, probably recent [40+ ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3533	Lateral myocardial infarction, probably old [40+ ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
3534	Lateral myocardial infarction, age undetermined [40+ ms Q wave in 2 leads among I, aVL, V5, V6]	abnormal ECG

Inferior Myocardial Infarction

◆Analysis criteria

Age classification	Criteria	Other
Acute (?)	STM and STE > 0.1 mV in Ⅱ and aVF and Modified T amplitude ≧ 0* in Ⅱ and aVF	
Recent (?)	STM and STE > 0.05 mV in Ⅱ or aVF and Modified T amplitude < 0* in Ⅱ or aVF	
Old (?)	STM < 0.03 mV in Ⅱ and aVF and Modified T amplitude ≧ 0* in Ⅱ and aVF	Acute (?) and Recent (?) are not satisfied.
Age undetermined	Acute (?), Recent (?) and Old (?) are not satisfied.	

Level classification	Criteria	Other
Cannot rule out	Q duration ≧ 30 ms in Ⅱ or aVF and Q amplitude (Ⅰ) < Q amplitude (Ⅱ) or Q duration ≧ 30 ms in Ⅱ or aVF and Q amplitude (Ⅰ) < Q amplitude (aVF)	
Possible	Q duration ≧ 35 ms in Ⅱ or aVF	Cannot rule out is satisfied.
(Determined)	Cannot rule out is satisfied and Q duration ≧ 40 ms in Ⅱ or aVF or Cannot rule out is satisfied and Recent (?) is satisfied or Cannot rule out is satisfied and Acute (?) is satisfied.	

Findings	Criteria
Posterior Extension	Any of the inferior myocardial infarction is satisfied. and complete RBBB is not present. and Q amplitude = 0 mV (in V1 and V2) and R duration ≧ 40 ms (in V1 and V2) or R duration ≧ 35 ms and Net QRS amplitude > 0 mV (in V1 or V2) or R duration ≧ 30 ms and Net QRS > 0 (in V1 and V2)

* Refer to p. 3-7 (c) and (d) for measurement method.

◆ Code and findings

Code	Findings [Criteria]	Judgement
3613	Cannot rule out inferior myocardial infarction, probably old [30 ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36132	Cannot rule out inferior myocardial infarction with posterior extension, probably old [30 ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3614	Cannot rule out inferior myocardial infarction, age undetermined [30 ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36142	Cannot rule out inferior myocardial infarction with posterior extension, age undetermined [30 ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3621	Possible inferior myocardial infarction, possibly acute [35 ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36212	Possible inferior myocardial infarction with posterior extension, possibly acute [35 ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3622	Possible inferior myocardial infarction, probably recent [35 ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36222	Possible inferior myocardial infarction with posterior extension, probably recent [35 ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3623	Possible inferior myocardial infarction, probably old [35 ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36232	Possible inferior myocardial infarction with posterior extension, probably old [35 ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3624	Possible inferior myocardial infarction, age undetermined [35 ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36242	Possible inferior myocardial infarction with posterior extension, age undetermined [35 ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3631	Inferior myocardial infarction, possibly acute [40+ ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36312	Inferior myocardial infarction with posterior extension, possibly acute [40+ ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG

Code	Findings [Criteria]	Judgement
3632	Inferior myocardial infarction, probably recent [40+ ms Q wave in lead Ⅱ / aVF]	abnormal ECG
36322	Inferior myocardial infarction with posterior extension, probably recent [40+ ms Q wave in lead Ⅱ / aVF with prominent R in lead V1/V2]	abnormal ECG
3633	Inferior myocardial infarction, probably old [40+ ms Q wave in lead Ⅱ/aVF]	abnormal ECG
36332	Inferior myocardial infarction with posterior extension, probably old [40+ ms Q wave in lead Ⅱ/aVF with prominent R in lead V1/V2]	abnormal ECG
3634	Inferior myocardial infarction, age undetermined [40+ ms Q wave in lead Ⅱ/aVF]	abnormal ECG
36342	Inferior myocardial infarction with posterior extension, age undetermined [40+ ms Q wave in lead Ⅱ/aVF with prominent R in lead V1/V2]	abnormal ECG

Children

With children under 18 years old, the following analysis are executed. The criteria are the same as the myocardial infarction. When the last number of the code (right) is 1, see the criteria for the code with the same first 4 numbers. When the last number is 3, see the criteria for the code with the same first 4 numbers but with the last (fifth) number 2.

For example, for the criteria of 31211 see the code 3121. For 36213, see the code 36212.

◆ Code and findings

Code	Findings [Criteria]	Judgement
31211	Abnormal Q wave in lead V3/V4, cannot rule out cardiomyopathy [35 ms Q wave in lead V3/V4, under 18 years]	abnormal ECG
31221	Abnormal Q wave in lead V3/V4, cannot rule out cardiomyopathy [35 ms Q wave in lead V3/V4, under 18 years]	abnormal ECG
31311	Abnormal Q wave in lead V3/V4, cannot rule out cardiomyopathy [40+ ms Q wave in lead V3/V4, under 18 years]	abnormal ECG
31321	Abnormal Q wave in lead V3/V4, cannot rule out cardiomyopathy [40+ ms Q wave in lead V3/V4, under 18 years]	abnormal ECG
32211	Abnormal Q wave in lead V2+V3/V4, cannot rule out cardiomyopathy [35 ms Q wave in lead V2+V3/V4, under 18 years]	abnormal ECG
32221	Abnormal Q wave in lead V2+V3/V4, cannot rule out cardiomyopathy [35 ms Q wave in lead V2+V3/V4, under 18 years]	abnormal ECG
32311	Abnormal Q wave in lead V2+V3/V4, cannot rule out cardiomyopathy [40+ ms Q wave in lead V2+V3/V4, under 18 years]	abnormal ECG
32321	Abnormal Q wave in lead V2+V3/V4, cannot rule out cardiomyopathy [40+ ms Q wave in lead V2+V3/V4, under 18 years]	abnormal ECG
33211	Abnormal Q wave in lead I/aVL/V3-V6, cannot rule out cardiomyopathy [35 ms Q wave in lead V3/V4+2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
33221	Abnormal Q wave in lead I/aVL/V3-V6, cannot rule out cardiomyopathy [35 ms Q wave in lead V3/V4+2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG

Code	Findings [Criteria]	Judgement
33311	Abnormal Q wave in lead I/aVL/V3-V6, cannot rule out cardiomyopathy [40＋ms Q wave in lead V3/V4＋2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
33321	Abnormal Q wave in lead I/aVL/V3-V6, cannot rule out cardiomyopathy [40＋ms Q wave in lead V3/V4＋2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
34111	Abnormal Q wave in lead V2, cannot rule out cardiomyopathy [30 ms Q wave in lead V2, under 18 years]	abnormal ECG
34121	Abnormal Q wave in lead V2, cannot rule out cardiomyopathy [30 ms Q wave in lead V2, under 18 years]	abnormal ECG
34211	Abnormal Q wave in lead V2, cannot rule out cardiomyopathy [35 ms Q wave in lead V2, under 18 years]	abnormal ECG
34221	Abnormal Q wave in lead V2, cannot rule out cardiomyopathy [35 ms Q wave in lead V2, under 18 years]	abnormal ECG
34311	Abnormal Q wave in lead V2, cannot rule out cardiomyopathy [40 ms Q wave in lead V2, under 18 years]	abnormal ECG
34321	Abnormal Q wave in lead V2, cannot rule out cardiomyopathy [40 ms Q wave in lead V2, under 18 years]	abnormal ECG
35211	Abnormal Q wave in lead I/aVL/V5/V6, cannot rule out cardiomyopathy [35 ms Q wave in 2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
35221	Abnormal Q wave in lead I/aVL/V5/V6, cannot rule out cardiomyopathy [35 ms Q wave in 2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
35311	Abnormal Q wave in lead I/aVL/V5/V6, cannot rule out cardiomyopathy [40＋ms Q wave in 2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
35321	Abnormal Q wave in lead I/aVL/V5/V6, cannot rule out cardiomyopathy [40＋ms Q wave in 2 leads among I, aVL, V5, V6, under 18 years]	abnormal ECG
36211	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [30 ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG
36221	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [35 ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG

Code	Findings [Criteria]	Judgement
36311	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [40+ ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG
36321	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [40+ ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG
36213	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [35 ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG
36223	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [35 ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG
36313	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [40+ ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG
36323	Abnormal Q wave in lead Ⅱ/aVF, cannot rule out cardiomyopathy [40+ ms Q wave in lead Ⅱ/aVF, under 18 years]	abnormal ECG

6-4 ST-T Abnormality

ST depression 6-4-1

Injury 6-4-3

Subendocardial Ischemia 6-4-7

Early Repolarization 6-4-10

Pericarditis 6-4-11

T wave Abnormality 6-4-12

Nonspecific ST Elevation 6-4-14

ST Depression

◆Analysis criteria

(1)
- Nonspecific intraventricular conduction block
- RBBB *
- LBBB
- ST elevation *
- Possible acute pericarditis
- RVH (with repolarization abnormality) *
- LVH (with repolarization abnormality)

When any of these findings is recognized, the process of "(2) ST depression classification" is omitted. However, when the findings marked with "*" are recognized, ST depression classification is performed, but for RBBB and RVH (repolarization abnormality), leads V1 and V2 are not analyzed.

(2) ST depression classification

Processing the data of all the leads except for aVR and Ⅲ, the system adopts the finding uniformly judged by the data of two or more leads.

When the age is less than 16, V1 and V2 leads are not considered for "ST depression, possible digitalis effect" and "Minimal ST depression".

Classification	STJ	STM	STE
Junctional ST depression, probably normal	< −0.1 mV		≧ 0 mV
Abnormal junctional ST depression	< −0.1 mV		< 0 mV and ≧STJ/2
ST depression, possible digitalis effect		<STJ and < −0.05 mV	
			< STJ and < −0.05 mV
Minimal ST depression	< −0.025 mV	< −0.025 mV	< −0.025 mV
Moderate ST depression		< −0.05 mV	< 0 mV
			< STJ and <STM and < − 0.05 mV
* Marked ST depression, possible subendocardial injury	< −0.1 mV	< −0.1 mV	< −0.1 mV
Marked ST depression consistent with subendocardial injury	< −0.2 mV	< −0.2 mV	< −0.2 mV

NOTE

- When the finding marked with "*", i.e. "marked ST depression, possible subendocardial injury" is judged, and at the same time "atrial fibrillation" is found, "possible digitalis effect" is added to the findings.
- When any of the ST depression findings is recognized, "nonspecific ST elevation" is not analyzed.

◆Code and findings

Code	Findings [Criteria]	Judgement
40106	ST depression, possible digitalis effect [Downsloping or curved ST depression]	abnormal ECG
4011	Minimal ST depression [0.025 + mV ST depression]	borderline ECG
40116	Minimal ST depression, probably digitalis effect [0.025 + mV ST depression]	borderline ECG
4012	Moderate ST depression [0.05 + mV ST depression]	abnormal ECG
40126	Moderate ST depression, probably digitalis effect [0.05 + mV ST depression]	abnormal ECG
4016	Marked ST depression, possible subendocardial injury [0.1 + mV ST depression]	abnormal ECG
40166	Marked ST depression, possible subendocardial injury or digitalis effect [0.1 + mV ST depression]	abnormal ECG
4017	Marked ST depression, consistent with subendocardial injury [0.2 + mV ST depression]	abnormal ECG
4021	Junctional ST depression, probably normal [0.1 + mV junctional ST depression with weak upslope]	borderline ECG
4023	Abnormal junctional ST depression [0.1 + mV junctional ST depression]	borderline ECG

Injury

◆Analysis criteria

(1) ● Left bundle branch block
● Right bundle branch block
● Nonspecific ventricular conductive defect
● Possible acute percarditis

} When any of these findings is recognized, subendocardial injury is not analyzed.

(2) Injury Classification

Portion	Finding	Judgement Criteria	Lead
Anterior	Possible injury or acute infarct	STJ > STLMT/2 and T wave is not upward oriented and the finding of possible or determined left ventricular hypertrophy is not present and the finding of anterior myocardial infarction is not present.	2 leads or more among V2, V3, V4, V5
		STJ > Total QRS amplitude/6 and the finding of possible or determined left ventricular hypertrophy is not present and the findings of anterior myocardial infarction are not present.	2 leads or more among V2, V3, V4, V5
	Injury or acute infarct	Possible anterior injury or acute infarct is satisfied and STJ > Total QRS amplitude/4	2 leads or more among V2, V3, V4, V5
Septal	Possible injury or acute infarct	STJ > STLMT/2 and T wave is not upward oriented and the findings of possible or determined left ventricular hypertrophy are not present and the findings of septal myocardial infarction are not present.	V1 and V2
		STJ > Total QRS amplitude/6 and the finding of possible or determined left ventricular hypertrophy is not present and the findings of septal myocardial infarction are not present.	V1 and V2
	Injury or acute infarct	Possible septal injury or acute infarct is satisfied and STJ > Total QRS amplitude/4	V1 and V2

Portion	Finding	Judgement Criteria	Lead
Anteroseptal	Possible injury or acute infarct	Possibility of anterior and septal injury or acute infarct is satisfied and possible anterolateral injury or acute infarct is not satisfied.	
	Injury or acute infarct	Possible anteroseptal injury or acute infarct is satisfied and septal injury or acute infarct is satisfied.	
		Possible anteroseptal injury or acute infarct is satisfied and anterrior injury or acute infarct is satisfied.	
Lateral	Possible injury or acute infarct	STJ > STLMT/2 and T wave is not upward oriented and the findings of lateral myocardial injury are not present.	2 leads or more among I, aVL, V5, V6
		STJ > Total QRS amplitude/6 and the findings of lateral myocardial injury are not present.	I, aVL, V5, and V6
	Injury or acute infarct	Possible lateral injury or acute infarct is satisfied and STJ > Total QRS amplitude/4	2 leads or more among I, aVL, V5, V6
Anterolateral	Possible injury or acute infarct	Possibility of anterolateral and lateral injury or acute infarct is satisfied.	
	Injury or acute infarct	Possible anterolateral injury or acute infarct is satisfied. and anterrior injury or acute infarct is satisfied.	
		Possible anterolateral injury or acute infarct is satisfied and lateral injury or acute infarct is satisfied.	

Portion	Finding	Judgement Criteria	Lead
Inferior	Possible injury or acute infarct	STJ > SLMT/2 and T wave is not upward oriented and the findings of inferior myocardial infarction are not present.	II and aVF
		STJ > Total QRS amplitude/6 and the findings of inferior myocardial infarction are not present.	II and aVF
	Injury or acute infarct	Possible inferior injury or acute infarct is satisfied and STJ > Total QRS amplitude/4	II and aVF

STLMT is used for comparison of STJ. The values are as below.

limb leads : STLMT = 0.3 mV

chest leads : STLMT = 0.3 mV (Net QRS amplitude ≧ 0 mV)

STLMT = 0.4 mV (Net QRS amplitude < 0 mV)

NOTE

(1) When injury or possible injury is found, the following findings are not printed out:
- ST elevation, probably early repolarization
- Early repolarization
- ST elevation consistent with epicardial injury, pericarditis, or early repolarization.
- Nonspecific ST elevation

(2) Relationship between injury portion and leads
The portion of the injury is judged by the relationship between the standard 12 leads and the heart portions as shown in the table on the next page.

(3) For the method of measuring upward T, refer to p. 3-7 (c).

(4) For the method of measuring total QRS amplitude and net QRS amplitude, refer to p. 3-6.

Portion	Ⅰ	Ⅱ	Ⅲ	aVR	aVL	aVF	V1	V2	V3	V4	V5	V6
Anterior								*	*	*	*	
Anteroseptal							*	*	*	*	*	
Anterolateral	*				*			*	*	*	*	*
Septal							*	*				
Lateral	*				*						*	*
Inferior		*				*						

◆Code and findings

Code	Findings [Criteria]	Judgement
4136	Possible anterior injury or acute infarct [ST elevation w/o normally inflected T wave in 2 leads among V2-V5]	abnormal ECG
4137	Anterior injury or acute infarct [Marked ST elevation w/o normally inflected T wave in 2 leads among V2-V5]	abnormal ECG
4236	Possible anteroseptal injury or acute infarct [ST elevation w/o normally inflected T wave in lead V1＋V2 and in 2 leads among V2-V5]	abnormal ECG
4237	Anteroseptal injury or acute infarct [Marked ST elevation w/o normally inflected T wave in lead V1＋V2 and in 2 leads among V2-V5]	abnormal ECG
4336	Possible anterolateral injury or acute infarct [ST elevation w/o normally inflected T wave in 2 leads among I, aVL, V5, V6 and in 2 leads among V2-V5]	abnormal ECG
4337	Anterolateral injury or acute infarct [Marked ST elevation w/o normally inflected T wave in 2 leads among I, aVL, V5, V6 and in 2 leads among V2-V5]	abnormal ECG
4436	Possible septal injury or acute infarct [ST elevation w/o normally inflected T wave in lead V1 ＋V2]	abnormal ECG
4437	Septal injury or acute infarct [Marked ST elevation w/o normally inflected T wave in lead V1＋V2]	abnormal ECG
4536	Possible lateral injury or acute infarct [ST elevation w/o normally inflected T wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
4537	Lateral injury or acute infarct [Marked ST elevation w/o normally inflected T wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
4636	Possible inferior injury or acute infarct [ST elevation w/o normally inflected T wave in lead Ⅱ ＋aVF]	abnormal ECG
4637	Inferior injury or acute infarct [Marked ST elevation w/o normally inflected T wave in lead Ⅱ ＋aVF]	abnormal ECG

Subendocardial Ischemia

◆Analysis criteria

(1) ● Nonspecific intraventricular conduction block
● LBBB
● Myocardial infarction in relevant portion
● Subendocardial injury
● Possible subendocardial injury
● Possible acute pericarditis
● Marked ST depression consistent with subendocardial injury
● RVH (repolarization abnormality)
● LVH (repolarization abnormality)

When any of these findings is recognized, T wave abnormality and ST-T wave abnormality are not analyzed.

(2) T wave abnormality and ST-T wave abnormality classification

Portion	Finding	Criteria	Lead	Judgement criteria
Anterior	T wave abnormality (Possible subendocardial ischemia)	modified T amplitude < -0.1 mV	V3 and V4	Cannot rule out anterior myocardial infarction is not satisfied.
			two or more leads among V2, V3 and V4	Cannot rule out anterior myocardial infarction is not satisfied. Complete RBBB is not satisfied. Age $\geqq$ 16 years old
	T wave abnormality (subendocardial ischemia)	modified T amplitude < -0.5 mV	V3 or V4	Possible anterior subendocardial ischemia is satisfied
			any of V2, V3 and V4	Possible anterior subendocardial ischemia is satisfied Complete RBBB is not satisfied. Age $\geqq$ 16 years old
Lateral	T wave abnormality (Possible subendocardial ischemia)	modified T amplitude < -0.1 mV	two or more leads among I, V4, V5 and V6	Cannot rule out lateral myocardial infarction is not satisfied.
		maximum R amplitude > 0.5 mV modified T amplitude < -0.1 mV	aVL at least two in I, aVL, V4, V5 and V6	Cannot rule out lateral myocardial infarction is not satisfied.

Portion	Finding	Criteria	Lead	Judgement criteria
Lateral	T wave abnormality (subendocardial ischemia)	modified T amplitude < -0.5 mV	any of I, V5 and V6	Possible lateral subendocardial ischemia is satisfied
		maximum R amplitude > 0.5 mV modified T amplitude < -0.5 mV	aVL any of I, aVL, V5 and V6	Possible lateral subendocardial ischemia is satisfied
Inferior	T wave abnormality (Possible subendocardial ischemia)	modified T amplitude < 0 mV modified T amplitude < -0.1 mV	Ⅱ and aVF Ⅱ	Cannot rule out inferior myocardial infarction is not satisfied.
		modified T amplitude < 0 mV modified T amplitude < -0.1 mV Net QRS amplitude > 0 mV	Ⅱ and aVF aVF aVF	Cannot rule out inferior myocardial infarction is not satisfied.
	T wave abnormality (subendocardial ischemia)	modified T amplitude < -0.5 mV	Ⅱ or aVF	Possible inferior subendocardial ischemia is satisfied
		Net QRS amplitude > 0 mV modified T amplitude < -0.5 mV	aVF aVF	Possible inferior subendocardial ischemia is satisfied

NOTE

- When atrial fibrillation is judged together with subendocardial ischemia, "possible digitalis effect" is added to the findings.
- When both anterior ischemia and lateral ischemia are judged, anterolateral ischemia is printed out.

◆ Code and findings

Code	Findings [Criteria]	Judgement
4164	T wave abnormality, possible anterior ischemia [−0.1 mV T wave in lead V3/V4]	abnormal ECG
41646	T wave abnormality, possible anterior ischemia or digitalis effect [−0.1 mV T wave in lead V3/V4]	abnormal ECG
4165	T wave abnormality, consistent with anterior ischemia [−0.5 mV T wave in lead V3/V4]	abnormal ECG
4364	T wave abnormality, possible anterolateral ischemia [−0.1 mV T wave in lead V3+V4 and in 2 leads among I, aVL, V5, V6]	abnormal ECG
43646	T wave abnormality, possible anterolateral ischemia or digitalis effect [−0.1 mV T wave in lead V3+V4 and in 2 leads among I, aVL, V5, V6]	abnormal ECG
4365	T wave abnormality, consistent with anterolateral ischemia [−0.5 mV T wave in lead V3+V4 and in 2 leads among I, aVL, V5, V6]	abnormal ECG
4564	T wave abnormality, possible lateral ischemia [−0.1 mV T wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
45646	T wave abnormality, possible lateral ischemia or digitalis effect [−0.1 mV T wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
4565	T wave abnormality, consistent with lateral ischemia [−0.5 mV T wave in 2 leads among I, aVL, V5, V6]	abnormal ECG
4664	T wave abnormality, possible inferior ischemia [−0.1 mV T wave in lead Ⅱ/aVF]	abnormal ECG
46646	T wave abnormality, possible inferior ischemia or digitalis effect [−0.1 mV T wave in lead Ⅱ/aVF]	abnormal ECG
4665	T wave abnormality, consistent with inferior ischemia [−0.5 mV T wave in lead Ⅱ/aVF]	abnormal ECG

Early Repolarization

◆Analysis criteria

(1)
- QTc interval > 450 ms
- Nonspecific intraventricular conduction block
- RBBB
- LBBB
- Myocardial infarction
- LVH

} When any of these findings is recognized, the analysis processes of (2) and (3) are not executed.

(2) When following two conditions are satisfied, the total number of the leads and the total amplitude of STJ are used to classify the ECG data as shown in (3).
- Chest lead: STJ and STM amplitude > 0.075 mV (age ≧ 20 years old)
  STJ and STM amplitude > 0.150 mV (age < 20 years old)
- Limb lead: STJ and STM amplitude > 0.049 mV (age ≧ 20 years old)
  STJ and STM amplitude > 0.099 mV (age < 20 years old)

(3) Classification

Findings	No. of leads	Total STJ amplitude	T waveform *
ST elevation consistent with subepicardial, pericarditis, or early repolarization	2 or more	≧ 0.45 mV (Age ≧ 20 years old) ≧ 0.90 mV (Age < 20 years old)	not upward
ST elevation, probably early repolarization	2 or more	≧ 0.45 mV (Age ≧ 20 years old) ≧ 0.90 mV (Age < 20 years old)	upward in more than half the number of leads satisfied (2)
Early repolarization	6 or more	≧ 0.45 mV	

* For the method of measuring upward T waveform, refer to p. 3-7 (c).

◆Code and findings

Code	Findings [Criteria]	Judgement
40302	ST elevation, probably early repolarization	borderline ECG
40303	Early repolarization	normal ECG
40371	ST elevation, consistent with subepicardial injury, pericarditis, or early repolarization [ST elevation w/o normally inflected T wave]	abnormal ECG

Pericarditis

◆Analysis criteria

(1)
- Nonspecific intraventricular conduction block
- RBBB
- LBBB
- Myocardial infarction
- LVH

} When any of these findings is recognized, the analysis processes of (2), (3) and (4) are not executed.

(2) The number of leads that satisfy the following conditions is counted.
- STJ and STM amplitude > 0.075 mV (in Ⅰ, Ⅱ, aVF)
- STJ and STM amplitude > 0.09 mV (in V2 ~ V6)

(3) The number of leads that satisfy the following conditions is counted.
- STJ and STM amplitude > 0.09 mV (in Ⅰ, Ⅱ, aVF)
- STJ and STM amplitude > 0.11 mV (in V2 ~ V6)

(4) Classification

Findings	STJ amplitude × 4	STJ and STM amplitude	No. of leads
Possible acute pericarditis (40304)	> T amplitude > 0 mV 4 or more leads among Ⅰ, Ⅱ, V4, V5, V6	> −0.1 mV All leads other than aVR	5 or more leads in (2)
Possible acute pericarditis (40305)	> T amplitude > 0 mV 4 or more leads among Ⅰ, Ⅱ, V4, V5, V6	> −0.1 mV All leads other than aVR	5 or more leads in (3)

NOTE

When "possible acute pericarditis" is found, the following findings are not printed out.
- ST elevation, probably early repolarization
- Early repolarization
- ST elevation, consistent with subendocardial injury, pericarditis, or early repolarization
- Nonspecific ST elevation

◆Code and findings

Code	Findings [Criteria]	Judgement
40304	Possible acute pericarditis [marked ST elevation w/o normally inflected T wave]	abnormal ECG
40305	Possible acute pericarditis [marked ST elevation w/o normally inflected T wave]	abnormal ECG

T Wave Abnormality

◆Analysis criteria

(1)
- Nonspecific intraventricular conduction block
- RBBB
- LBBB
- Myocardial infarction
- Possible acute pericarditis
- ST elevation
- Subendocardial injury
- Subendocardial ischemia
- RVH (repolarization abnormality)
- LVH (repolarization abnormality)

} When any of these findings is recognized, the analysis processes of (2) and (3) are not executed.

(2) Classification 1

Findings	Modified T amplitude*	Maximum R amplitude	ST abnormality	Tall T wave
Nonspecific T wave abnormality	< T min 2 or more leads among Ⅰ, Ⅱ, aVL, aVF, V3~V6	>0.5 mV In same leads as left		
Nonspecific ST&T abnormality	< T min 2 or more leads among Ⅰ, Ⅱ, aVL, aVF, V3~V6	>0.5 mV In same leads as left	Present	Absent

Here, T min is defined as follows:

1: Net QRS amplitude > 0 mV: T min = 0.025 mV + Net QRS amplitude/20

2: Net QRS amplitude < 0 mV: T min = 0.025 mV

* For the method of measuring modified T amplitude, refer to p. 3-7 (d).

(3) Classification 2

When QTc ≦ 0.45 s, the following analysis is made.

Findings	T amplitude
Tall T wave, possible hyperkalemia	(1) > 1.0 mV > R amplitude/2 3 or more leads among Ⅰ, Ⅱ, V1 ~ V6 (2) > 1.5 mV > R amplitude/2 any lead among Ⅰ, Ⅱ, V1 ~ V6

NOTE

When "nonspecific T wave abnormality" or "nonspecific ST&T wave abnormality" is recognized with "atrial fibrillation", "probably digitalis effect" is added to the findings.

◆Code and findings

Code	Findings [Criteria]	Judgement
4048	Nonspecific ST&T wave abnormality	normal ECG
40486	Nonspecific ST&T wave abnormality, probably digitalis effect	borderline ECG
4050	Tall T waves, possible hyperkalemia [T > both 1/2 R and lmV in 3 leads]	abnormal ECG
4068	Nonspecific T wave abnormality	borderline ECG
40686	Nonspecific T wave abnormality, probably digitalis effect	borderline ECG

Nonspecific ST Elevation

◆Analysis criteria

(1)
- Nonspecific intraventricular conduction block
- RBBB
- LBBB
- Myocardial infarction
- LVH (repolarizaion abnormality)

} When any of these findings is recognized, the analysis process for (2), is not executed.

(2)
STJ ≧ 0.049 mV (Age ≧ 20 years old) :
STJ ≧ 0.099 mV (Age < 20 years old) : } 2 or more leads in I, II, III, aVF,V3, V4, V5 and V6

STM ≧ 0.049 mV (Age ≧ 20 years old) :
STM ≧ 0.099 mV (Age < 20 years old) : } In same leads as above.

STE ≧ 0.049 mV (Age ≧ 20 years old) :
STE ≧ 0.099 mV (Age < 20 years old) : } In same leads as above.

T wave is not upward* : In same leads as above.

* For measurement method, refer to p. 3-7 (c).

◆Code and findings

Code	Findings [Criteria]	Judgement
4038	Nonspecific ST elevation [0.05 + mV ST elevation]	normal ECG

6-5 Ventricular Hypertrophy

Point Score System 6-5-1

Analysis Criteria for RVH 6-5-1
5120 Possible right ventricular hypertrophy 6-5-3
5130 Right ventricular hypertrophy 6-5-3
5134 Right ventricular hypertrophy, probably repolarization abnormality 6-5-4

Analysis Criteria for LVH 6-5-5
5211 Minimal voltage criteria for LVH, may be normal variant 6-5-6
5220 Possible left ventricular hypertrophy 6-5-6
5222 Moderate voltage criteria for LVH, may be normal variant 6-5-6
5233 Voltage criteria for LVH 6-5-6
5234 Left ventricular hypertrophy with repolarization abnormality 6-5-6

Point Score System

For judging cardiac hypertrophy, the major identifying features such as amplitude, QRS duration and repolarization abnormality are given points that vary with age and sex, and their total is used as the criteria.

Analysis Criteria for RVH

◆Analysis criteria

① Complete RBBB
② Complete LBBB
③ QRS duration > 140 ms, net QRS duration < 0 mV (V1)

} When any of these findings is recognized, the analysis of RVH is not executed.

- Judgement criteria for ages 17 years old and below

No.	Judgement	Points
1	In V1 : Q amplitude > 0.04 mV R amplitude > 0.7 mV S amplitude < 0.5 mV	3
2	In V1 : R amplitude > 1.0 mV*	3
3	In V6 : S amplitude > 0.4 mV*	3
4	Right ventricular conduction delay is present and S amplitude (V1) < 0.5 mV, and R' amplitude > 1.0 mV (V1) (Age ≧ 1 year old) or R' amplitude > 1.5 mV (V1)	2
5	T amplitude (V1) ≧ 0, Age ≦ 9 years old	2
6	(RV1 + SV5) / (SV1 + RV5) > 1.0 (Age ≧ 3 years old)	3
7	Right axis deviation is present	2
8	Moderate right axis deviation is present	1
9	Moderate right axis deviation is present or Right axis deviation is present, and Incomplete right bundle branch block is present.	1

NOTE

When the below condition is satisfied, right ventricular hypertrophy is not analyzed:
maximum S depth > 2 × maximum R height (V1)

The values marked with "*" vary with age. Refer to p. 6-0-4 and 6-0-5.

- Judgement criteria for 18 years and over

No.	Judgement	Point
1	R or R' amplitude > 0.5 mV in V1	1
2	Net QRS amplitude >0 mV in V1	1
3	Net QRS amplitude > 0.5 mV in V1	1
4	Net QRS amplitude < 0 mV in V5 or V6 and S amplitude>0.5 mV in V5 or V6	1
5	QRS axis ≧ 90° (no unidentified axis)	1
6	QRS axis ≧ 100° (no unidentified axis)	1
7	QRS axis ≧ 110° (no unidentified axis)	1
8	Possible Right atrial enlargement is present	1
9	S pattern is present	1
10	Age > 30 years old	1
11	Unidentified axis is present	1

However, when the following conditions are satisfied, right ventricular hypertrophy is not analyzed.

① Q, S, S' amplitude< 0.25 mV in I
② QRS axis < 60°
③ Maximum S amplitude> 1 mV (in V1)

Code	Findings [Criteria]	Judgement
5120	Possible right ventricular hypertrophy [Some/all of; prominent R in V1, late transition, RAD, RAE, SSS]	borderline ECG
5130	Right ventricular hypertrophy [Some/all of; prominent R in V1, late transition, RAD, RAE, SSS]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Possible RVH	Points ≧ 4
RVH	Points ≧ 6

NOTE
When possible RVH is found, the following findings are not analyzed.

- Nonspecific intraventricular conduction delay
- RSR (QR) in lead V1/V2 consistent with right ventricular conduction delay
- Left posterior fascicular block
- Moderate right axis deviation
- Abnormal right axis deviation
- S1-S2-S3 pattern, consistent with pulmonary disease, RVH, or normal variant
- Low QRS voltage
- Low QRS voltage in limb leads
- Low QRS voltage in chest leads

Code	Findings [Criteria]	Judgement
5134	Right ventricular hypertrophy probably repolarization abnormality [Some/all of; prominent R in V1, late transition, RAD, RAE, SSS, ST depression in lead V1, V2, V3]	abnormal ECG

◆Analysis criteria

Findings	Criteria		
Right ventricular hypertrophy probably repolarization abnormality	(1) RVH or possible RVH	:	present
	(2) ① STJ > STM > STE	:	in V1, V2, V3
	② STM < −0.1 mV	:	in V1, V2, V3
	③ STE < −0.1 mV	:	in V1, V2, V3
	④ T amplitude < −0.1 mV	:	in V1, V2, V3
	(3) QRS duration < 120 ms *		

NOTE
The value marked with "*" varies with age. Refer to p. 6-0-2.

Analysis Criteria for LVH

(1) ① LBBB is present
② QRS duration > 0.14 s* and
Net QRS amplitude < 0 mV in V1

} When either of these findings is recognized, LVH is not analyzed.

* The value marked with * varies with age. Refer to p. 6-0-2.

(2) Point score calculation and classification
The following four items are analyzed and the points are calculated.
Obtained point scores and the respective finding analysis criteria are used to identify the findings given on p. 6-5-7.

Item	Lead	Judgement	Points
1. R or R' amplitude	aVL	> 1.1 mV	2 points, 1 point added at every + 0.1 mV
2. S or S' amplitude	V1	> Threshold value***	2 points, 1 point added at every + 0.2 mV*
3. R or R' amplitude	V5	> Threshold value***	2 points, 1 point added at every + 0.2 mV*
4. R or R' amplitude + S or S' amplitude	V5 or V6 V1	> Threshold value***	2 points, 1 point added at every +0.3 mV**

* : The values marked with "*" are used for 17 years old and over.
1 point is added at every another 0.3 mV when 16 years old and under.

** : The values marked with "**" is used for 17 years old and over.
1 point is added at every another 0.45 mV when 16 years old and under.

***: Threshold values for age groups are given below.

	R (V5)		S (V1)		R (V5/V6) + S (V1)	
YEARS	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
3 ~ 5	3.50 mV	3.50 mV	2.50 mV	2.50 mV	6.00 mV	6.00 mV
6 ~ 8	3.50 mV	3.50 mV	2.75 mV	2.75 mV	6.00 mV	6.00 mV
9 ~ 12	3.75 mV	3.50 mV	3.00 mV	3.00 mV	6.00 mV	5.30 mV
13 ~ 16	3.75 mV	3.00 mV	3.75 mV	3.00 mV	6.00 mV	4.80 mV
17 ~ 19	3.75 mV	3.00 mV	3.75 mV	3.00 mV	6.00 mV	4.50 mV
20 ~	3.00 mV	3.00 mV	3.00 mV	3.00 mV	4.50 mV	4.50 mV

Code	Findings [Criteia]	Judgement
5211	Minimal voltage criteria for LVH, may be normal variant [Meets criteria in one of; R(aVL), S(V1), R(V5), R(V5/V6)+S(V1)]	borderline ECG
5220	Possible left ventricular hypertrophy [Voltage criteria plus LAE or QRS widening]	abnormal ECG
5222	Moderate voltage criteria for LVH, may be normal variant [Meets criteria in one of; R(aVL), S(V1), R(V5), R(V5/V6)+S(V1)]	borderline ECG
5233	Voltage criteria for LVH [Meets criteria in one of; R(aVL), S(V1), R(V5), R(V5/V6)+S(V1)]	abnormal ECG
5234	Left ventricular hypertrophy with repolarization abnormality [Voltage criteria plus ST/T abnormality]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Minimal voltage criteria for LVH	Point ≧ 2
Moderate voltage criteria for LVH	Points ≧ 3
Voltage criteria for LVH	Points ≧ 5
Possible left ventricular hypertrophy	(1) Point ≧ 2 (2) ① Maximum change point of inclination − QRS start point > 68 ms (V5)* ② Left atrial enlargement or Possible right atrial enlargement.
Left ventricular hypertrophy with repolarization abnormality	(1) Point ≧ 2 (2) Atrial fibrillation is not present (3) ① T amplitude (V1) > T amplitude (V6) + 0.2 mV ② ● STE height < STJ height in any lead among Ⅰ, aVL, V4, V5, V6 ● STE height < −0.05 mV in same lead as above ● R amplitude > 1.1 mV in same lead as above

NOTE

- When left ventricular hypertrophy with repolarization abnormality is found, “Nonspecific intraventricular conduction delay”, “Incomplete left bundle branch block” and “ST-T Abnormality” are not analyzed.
- The value marked with “*” varies with age. Refer to p. 6-0-2.

6-6 Atrial Enlargement

6120	Possible right atrial enlargement	6-6-1
6130	Right atrial enlargement	6-6-1
6220	Possible left atrial enlargement	6-6-2
6230	Left atrial enlargement	6-6-2

Axis Deviation

7100	Abnormal right axis deviation	6-6-3
7102	Moderate right axis deviation	6-6-3
7200	Abnormal left axis deviation	6-6-3
7202	Moderate left axis deviation	6-6-3
7300	Indeterminate axis	6-6-3
7400	S1-S2-S3 pattern, consistent with pulmonary disease, RVH, or normal variant	6-6-5
7500	Abnormal QRS-T angle	6-6-6

Others

8003	Consistent with pulmonary disease	6-6-7
8100	Low QRS voltage	6-6-8
8101	Low QRS voltage in limb leads	6-6-8
8102	Low QRS voltage in chest leads	6-6-8
8200	Dextrocardia	6-6-9
8304	Long QTc interval	6-6-10
8305	Short QTc interval	6-6-10
0101	Possible arm leads reversed, check lead requested	6-6-11
0102	ARTIFACT PRESENT	6-6-12
0103	CANNOT ANALYSIS ECG	6-6-12
0104	ELECTRODE(S) FAILURE...Repeat ECG is required	6-6-12
0201	...Contour analysis based on intrinsic rhythm	6-6-12

Atrial Enlargement

Code	Findings [Criteria]	Judgement
6120	Possible right atrial enlargement [0.25 mV P wave]	borderline ECG
6130	Right atrial enlargement [0.3 mV P wave]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Possible right atrial enlargement	(1) Heart rate < 120/minute (2) P amplitude > 0.25 mV in any lead among Ⅱ, Ⅲ, aVF, V1, V2
Right atrial enlargement	(1) Heart rate < 120/minute (2) P amplitude > 0.3 mV in any lead among Ⅱ, Ⅲ, aVF, V1, V2

NOTE

- The reason for not analyzing when heart rate is over 120/minute is that at such a high heart rate, the increased P wave height may not definitely be caused by atrial enlargement.
- As shown in (2) in the table, when the P wave amplitude is 0.25~0.3 mV, the finding is marked “possible”.

Code	Findings [Criteria]	Judgement
6220	Possible left atrial enlargement [−0.1 mV P wave in lead V1]	borderline ECG
6230	Left atrial enlargement [−0.15 mV P wave in lead V1]	abnormal ECG

◆Analysis criteria

Findings	Criteria
Possible left atrial enlargement	(1) Negative P amplitude < -0.1 mV in V1 (2) Negative P area $\geqq 4.0$ mV × ms in same lead as above
Left atrial enlargement	(1) Negative P amplitude < -0.15 mV in V1 (2) Negative P area $\geqq 6.0$ mV × ms in same lead as above

NOTE
As shown in (1) in the table, when the negative P amplitude is between −0.15 and −0.1 mV, the finding is marked “possible”.

Abnormal Axis Deviation

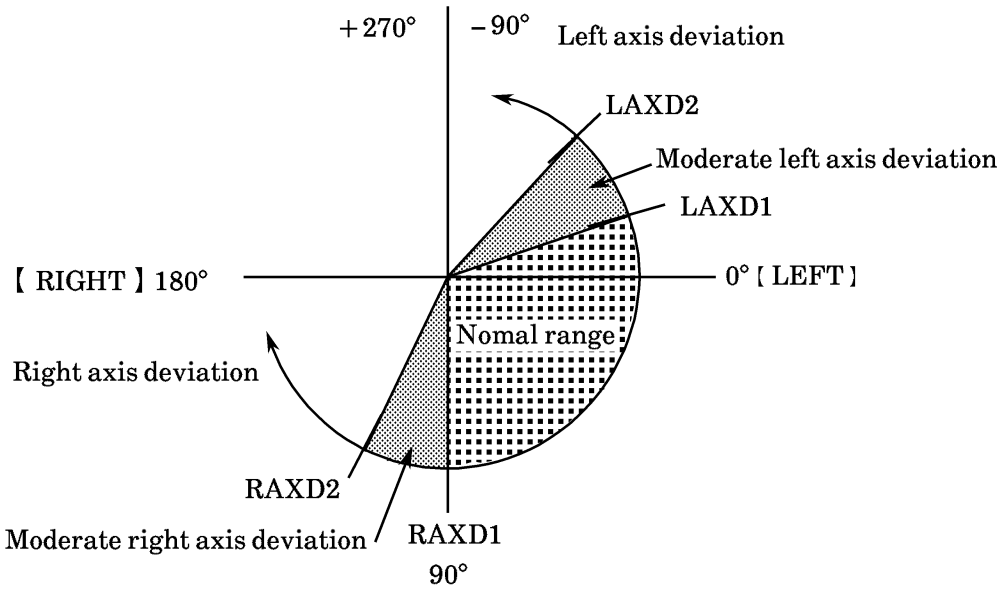
Code	Findings [Criteria]	Judgement
7100	Abnormal right axis deviation [QRS axis > 100]	borderline ECG
7102	Moderate right axis deviation [QRS axis > 90]	normal ECG
7200	Abnormal left axis deviation [QRS axis < −30]	borderline ECG
7202	Moderate left axis deviation [QRS axis < −20]	normal ECG
7300	Indeterminate axis	atypical ECG

◆Analysis criteria

Findings	Criteria
Moderate right axis deviation	90° < QRS axis ≦ 100° (RAXD1) *
Abnormal right axis deviation	100° < QRS axis ≦ 270° (RAXD2) *
Moderate left axis deviation	−30° ≦ QRS axis < −20° (LAXD1) *
Abnormal left axis deviation	−90° ≦ QRS axis < −30° (LAXD2) *
Indeterminate axis	Net QRS amplitude < 33% of total QRS amplitude in Ⅰ, Ⅱ, Ⅲ

NOTE

- The values marked with "*" vary with age. Refer to p. 6-0-3.



- When the measured values are at the boundary, the expression "moderate" is added to the findings.

- Since measuring the axis is irrelevant when the net QRS amplitude in Ⅰ, Ⅱ and Ⅲ is smaller than 1/3 of the total QRS amplitude, the expression "indeterminate" is used. (For net QRS amplitude and total QRS amplitude, refer to p. 3-6.)

Code	Findings [Criteria]	Judgement
7400	S1-S2-S3 pattern, consistent with pulmonary disease, RVH, or normal variant	borderline ECG

◆Analysis criteria

When QRS duration ≧ 120 ms *, S pattern is not analyzed.

The value marked with * varies with age. Refer to p. 6-0-2.

Findings	Criteria
S1-S2-S3 pattern	(1) ① R < S (amplitude) in Ⅰ, Ⅱ, Ⅲ ② ● S > 0.3 mV in Ⅰ ● S > 0.4 mV in Ⅱ ● S > 0.7 mV in Ⅲ (2) R' wave is not present in Ⅰ, Ⅱ, Ⅲ (3) S > 0.2 mV in Ⅰ, Ⅱ, Ⅲ (4) Age ≧ 16 years old

Code	Findings [Criteria]	Judgement
7500	Abnormal QRS-T angle [QRS-T axis difference > 60]	borderline ECG

◆Analysis criteria

(1)
- Nonspecific intraventricular conduction block
- RBBB
- LBBB
- Myocardial infarction
- ST elevation
- Subendocardial injury
- Acute pericarditis
- RVH (with repolarization abnormality)
- LVH (with repolarization abnormality)
- Possible marked ST depression consistent with subendocardial injury
- Age < 1 year old

} When any of these findings are recognized, the abnormal QRS-T angle is not analyzed.

Findings	Criteria	
	QRS axis - T axis	T axis
Abnormal QRS-T angle 1	> 60°	<0°
2	< −60°	> 90°

Others

Code	Findings [Criteria]	Judgement
8003	Consistent with pulmonary disease	abnormal ECG

◆Analysis criteria

Findings	Criteria
Consistent with pulmonary disease	(1) QRS duration < 120 ms* (2) Total points ≧ point 4

NOTE

- Pulmonary disease is judged from the points representing the features of pulmonary diseases. The point scores are calculated as shown in the table below. This logic is not enough to identify pulmonary diseases, but if 4 or more of these features in the table are present in the ECGs, the probability of pulmonary diseases can be said to be fairly high.

Features	Points
1. Right atrial enlargement or possible right atrial enlargement	1
2. −90° ≦ QRS axis < LAXD2*	1
3. RAXD1* < QRS axis ≦ 270°	1
4. Indeterminate axis	1
5. S1-S2-S3 pattern	1
6. Low QRS voltage in limb leads	1
7. Low QRS voltage in chest leads	1
8. (1) Net QRS amplitude < 0 mV in V5 (2) R (and R') amplitude < 0.5 mV in V6	3

- The value marked with "*" varies with age. Refer to p. 6-0-3.

Code	Findings [Criteria]	Judgement
8100	Low QRS voltage [QRS deflection < 0.5 mV in limb leads and <1.0 mV in chest leads]	abnormal ECG
8101	Low QRS voltage in limb leads [QRS deflection < 0.5 mV in limb leads]	atypical ECG
8102	Low QRS voltage in chest leads [QRS deflection < 1.0 mV in chest leads]	atypical ECG

◆Analysis criteria

Findings	Criteria
Low QRS voltage	(1) QRS duration < 0.12 s* (2) Total QRS amplitude < 0.5 mV in all limb leads (3) Total QRS amplitude < 1.0 mV in all chest leads
Low QRS voltage in limb leads	(1) QRS duration < 0.12 s* (2) Total QRS amplitude < 0.5 mV in all limb leads
Low QRS voltage in chest leads	(1) QRS duration < 0.12 s* (2) Total QRS amplitude < 1.0 mV in all chest leads

NOTE
The values marked with "*" vary with age. Refer to p. 6-0-2.

Code	Findings [Criteria]	Judgement
8200	Dextrocardia	atypical ECG

◆Analysis criteria

Findings	Criteria
Dextrocardia	(1) 90° < QRS axis ≦ 270° (2) 90° < P axis ≦ 270° (3) PR interval ≧ 110 ms* (4) ① Q wave is present in Ⅰ ② ● Q wave is not present in Ⅰ ● R amplitude < 0.15 mV in Ⅰ (5) R amplitude < 0.5 mV in V6 (6) Net QRS amplitude ≦ 0 mV in V6 (7) P amplitude < 0.02 mV in V6 (8) Negative P amplitude < −0.02 mV in V6

NOTE

- Refer to "0101 ARM LEADS REVERSED".
- The value marked with "*" varies with age. Refer to p. 6-0-1.

Code	Findings [Criteria]	Judgement
8304	Long QTc interval	abnormal ECG
8305	Short QTc interval	abnormal ECG

◆Analysis criteria

- Nonspecific intraventricular conduction block
- RBBB
- LBBB
- Myocardial infarction
- ST elevation (Subendocardial injury)
- Subendocardial ischemia
- Possible Acute pericarditis
- Marked ST depression (Subendocardial injury)
- RVH (with repolarization abnormality)
- LVH (with repolarization abnormality)
- Age < 1 year old

} When any of these findings are recognized, long QTc interval is not analyzed.

Findings	Criteria
Long QTc interval	QTc interval > 0.45 s
Short QTc interval	(1) QTc interval < 0.36 s (2) heart rate < 140/minute

Code	Findings [Criteria]	Judgement
0101	Possible arm leads reversed, check lead requested [Negative P, QRS wave (I)]	---

◆Analysis criteria

Findings	Criteria
ARM LEADS REVERSED	(1) 90° < QRS axis ≦ 270° (2) 90° < P axis ≦ 270° (3) PR interval ≧ 110 ms* (4) ① Q wave is present in Ⅰ ② ● Q wave is not present in Ⅰ ● R amplitude < 0.15 mV in Ⅰ (5) ① R amplitude ≧ 0.5 mV at V6 ② R amplitude > S amplitude in V6 ③ P amplitude ≧ 0.02 mV in V6 ④ Negative P amplitude ≧ −0.02 mV in V6

NOTE

- In properly recorded ECGs, the P and QRS waves of Lead Ⅰ are not expected to appear in negative simultaneously. If the type of QRS wave is Qr (or rSr'), the most probable cause is either dextrocardia or reversed arm lead electrodes. If the V6 lead shows the typical upward-oriented waveform, the probability of reversed electrode is high, otherwise, the probability for dextrocardia is high.

- Pulmonary disease tends to show right axis deviation in both P wave and QRS wave, and the rS type occurs. The same is true with other diseases which show right axis deviation. A Qr type rarely appears in myocardial infarction, but an inverted P is not expected to appear at the same time.

- Both "Arm leads reversed" and "Dextrocardia" have "inverted P and QRS wave" as criteria, but in the actual decision, the Qr or rSr type of QRS wave is taken as a significant factor.

- The value marked with "*" varies with age. Refer to p. 6-0-1.

Code	Findings [Criteria]	Judgement
0102	ARTIFACT PRESENT	---

Artifact on waveform.
Artifact may cause incorrect analysis. Remove artifacts and record ECG again.

Code	Findings [Criteria]	Judgement
0103	CANNOT ANALYSIS ECG	---

ECG could not be analyzed because

- Artifact on waveform, or
- Heart beats are too small, or
- The ECG has less than 3 heart beats which the instrument can measure.

Code	Findings [Criteria]	Judgement
0104	ELECTRODE(S) FAILURE...Repeat ECG is required.	---

Electrode detachment
Attach electrodes correctly and record ECG again.

Code	Findings [Criteria]	Judgement
0201	...Contour analysis based on intrinsic rhythm	---

Both artificial pacemaker rhythm and intrinsic heart beats are in ECG recording and the instrument analyzed intrinsic heart beats.
Refer to p. 6-1-6 (3) With pacemaker.

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